UNIVERSITY OF
ILLINOIS LIBRARY
AT URBANA-CHAMPAIGN
ACES

NOTICE: **Return or renew all Library Materials! The *Minimum* Fee for each Lost Book is $50.00.**

The person charging this material is responsible for its return to the library from which it was withdrawn on or before the **Latest Date** stamped below.

Theft, mutilation, and underlining of books are reasons for disciplinary action and may result in dismissal from the University.
To renew call Telephone Center, 333-8400

UNIVERSITY OF ILLINOIS LIBRARY AT URBANA-CHAMPAIGN

L161—O-1096

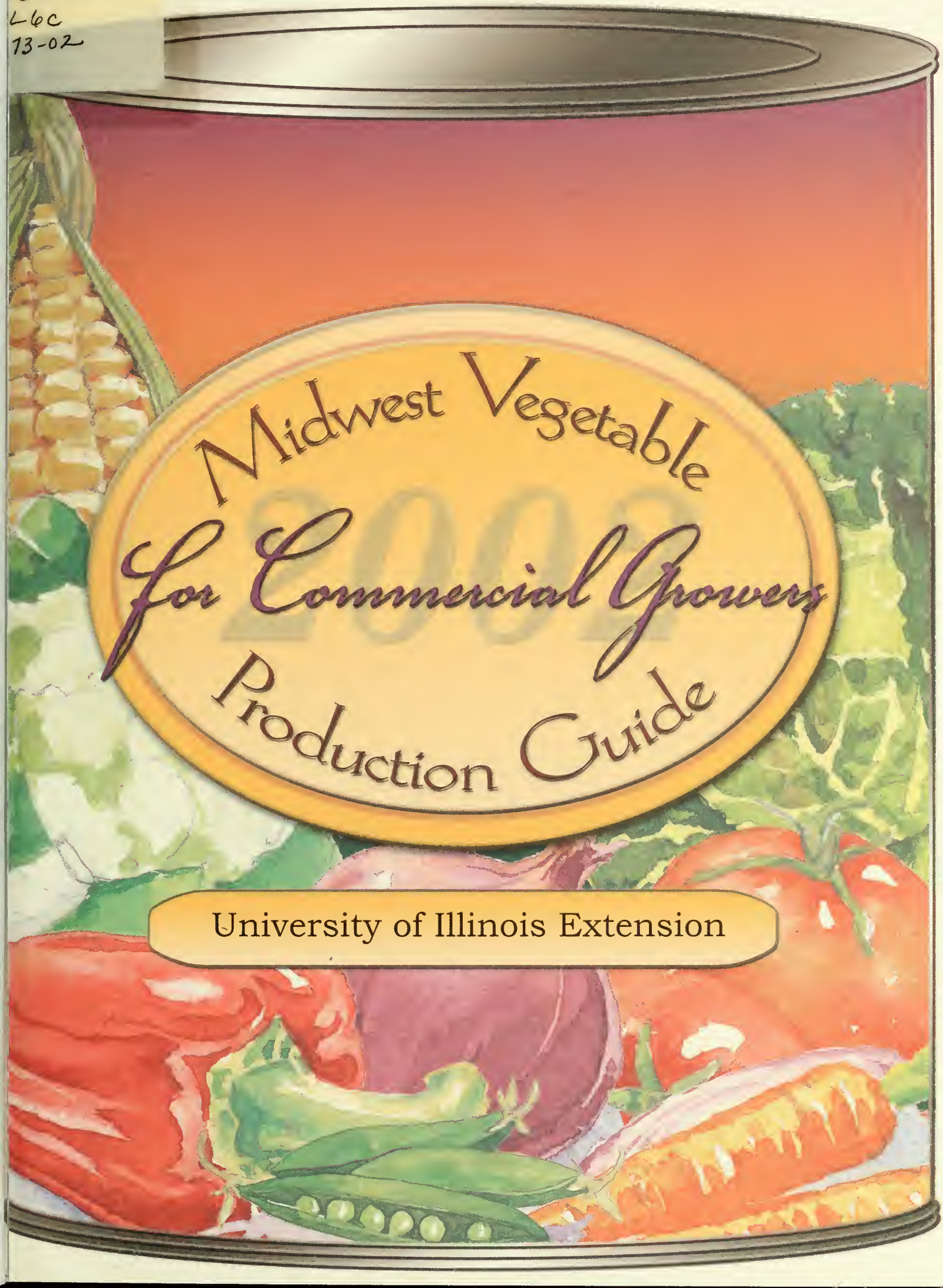
AGES LIBRARY
APR 1 3 2004
UNIVERSITY OF ILLINOIS

Digitized by the Internet Archive
in 2011 with funding from
University of Illinois Urbana-Champaign

http://www.archive.org/details/midwestvegetable1373univ

630.7
L6c
13-02

C1373-02



For the most up-to-date version of this publication visit the web site at:

http://www.entm.purdue.edu/entomology/ext/targets/ID/index.htm

Look under *Publications and Interdisciplinary Publications*. Changes will be made throughout the year as they are received.

Illinois Poison Information Centers

Nationwide Toll-Free Call 1-800-222-1222

Personnel at this number will give first aid instructions and direct callers to local treatment centers.

For immediate emergency treatment or ambulance service, always call 911.

UNIVERSITY OF
ILLINOIS LIBRARY
AT URBANA-CHAMPAIGN
ACES

ABBREVIATIONS FOR PESTICIDES

PHI	Pre-Harvest Interval, the minimum allowable time in days between the latest pesticide application and crop harvest
AI	Active Ingredient
COC	Crop Oil Concentrate
D	dust formulation
DF, DG	dry flowable or water dispersible granule formulation
E, EC	emulsifiable concentrate
F	flowable formulation
G	granular formulation
L, LC	liquid concentrate formulation
W, WP	wettable powder formulation
SC	suspension concentrate
RUP	Restricted Use Pesticide

The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by University of Illinois Extension is implied.

Insect, disease, and weed control recommendations in the publication are valid only for 2002. If registration for any of the chemicals suggested is changed during the year since the time of publication (December, 2001), we will inform all area and county Extension workers. If in doubt about the use of any chemical, check with your Extension agent or chemical company representative. The authors and University of Illinois Extension assume no liability for omission or for use or misuse of information contained herein.

Midwest Vegetable Production Guide for Commercial Growers 2002

Editors

Purdue University: Rick Foster, Entomology (Lead Author); Dan Egel, Botany and Plant Pathology; Elizabeth Maynard, Horticulture.
University of Illinois: Rick Weinzierl, Entomology; Mohammad Babadoost, Plant Pathology.
Iowa State University: Henry Taber, Horticulture.
University of Missouri: Lewis W. Jett, Horticulture.
University of Minnesota: Bill Hutchison, Entomology.

ACES LIBRARY
JAN 23 2002
UNIVERSITY OF ILLINOIS

Contributors

Purdue University: Rick Foster, Entomology; Dan Egel, Ralph Green, Richard Latin, Botany and Plant Pathology; Elizabeth Maynard, Steve Weller, Horticulture.
University of Illinois: Rick Weinzierl, Entomology; Mohammad Babadoost, Plant Pathology; John Masiunas, Horticulture.
Iowa State University: Mark Gleason, Plant Pathology; Vince Lawson, Henry Taber, Horticulture; Donald Lewis, Entomology.
University of Minnesota: Bill Hutchison, Dave Ragsdale, Entomology; Roger Jones, Plant Pathology; Roger Becker, Agronomy; Carl Rosen, Soil Science; Vince Fritz, Horticulture; Jerry Wright, Ag. Engineering.
University of Missouri: Bruce Barrett, Michael Boyd, Entomology; Pat Donald, Hal Shafer, Barb Corwin, Plant Pathology; Lewis W. Jett, Horticulture; Ray Nabors, Area Extension Specialist.

Contents

Reference Information Page

What's New in 2002? 2
Fertilization, Liming, & Soil Sampling 3
Transplant Production 4
Use of Plastic Mulch 7
Irrigation & Water Management 7
Chemigation Management 10
Time from Pollination to Market Maturity 11
Yields of Vegetable Crops 11
Postharvest Handling and Storage Life 12
Farm Labor Law Information 13
Precautions with Pesticides 13
Use of Bees with Vegetable Crops 15
Re-entry Standards/Worker Protection 16
Fungicide/Insecticide Compatibility Chart 17
Insect Management Strategies 18
PHI's and REI's for Insecticides 21
Common Names of Registered Insecticides 22
Weed Management Strategies 23
Herbicide Effectiveness Guide 30
PHI's and REI's for Herbicides 31
Common Names of Registered Herbicides 33
Disease Management Strategies 34
Common Names of Registered Fungicides 39
PHI's and REI's for Fungicides 40
Plant Parasitic Nematode Management 42
Slug & Snail Control 43
Calibration of Application Equipment 165
Pesticide Record-Keeping Form 166

Crop Recommendations

Asparagus 44
Beet 109
Broccoli 49
Brussels Sprouts 49

Crop Recommendations, cont. Page

Cabbage 49
Carrot 109
Cauliflower 49
Collard 115
Cowpea 83
Cucumber 57
Dry Bean 123
Eggplant 70
Endive 115
Herbs 115
Kale 115
Lettuce (Head and Leaf) 115
Lima Bean 123
Mint (Peppermint and Spearmint) 74
Muskmelon 57
Mustard 115
Onion (Bulb and Green) 77
Parsley 115
Parsnip 109
Pea 83
Pepper 88
Potato 95
Pumpkin 131
Radish 109
Rhubarb 107
Snap Bean 123
Spinach 115
Squash 131
Sweet Corn 139
Sweet Potato 149
Tomato 151
Turnip 109
Watermelon 57

What's New in 2002?

Highlights of Changes in This Edition

New and Revised Sections

- Nematode management section revised
- New section on chemigation

Varieties

- Pumpkins: Gold Standard, Gold Medal
- Sweet Corn: Serendipity
- Tomatoes: Florida 91

Disease Management

- Expanded label for Actigard 50WG; see Salad and Green crops. Also see write-up on page #.
- Expanded label for Flint WDG; see Pepper and Tomato
- Expanded label for Omega 500F; see Potatoes
- Expanded label for Switch 62.5WG; see Onions
- Messenger WDG is now labeled for several vegetable crops. See write-up on page #.
- Chlorothalonil: Several new formulations are listed and the REI has changed from 48 to 12 hours. See label for restrictions.
- Pea disease section has been expanded

Weed Management

- Command 3 ME (clomazone) labeled for preplant application in cabbage, cucumber, muskmelon, snap bean, squash, sweet potato, watermelon
- Select (clethodim) labeled for postemergence grass control in carrot, cucumber, eggplant, muskmelon, pepper, potato, pumpkin, radish, squash, sweet potato, watermelon

Insect Management

- Confirm 2F (tebufenozide) now labeled for broccoli, brussel sprouts, cabbage, sauliflower, collard, eggplant, endive, lettuce, mustard, pepper, ruhubarb, and spinach
- Platinum 2S and Actara 25WDG (both thiamethoxam) labeled for use on cantaloupe, cucumber, eggplant, pepper, potato, pumpkin, summer squash, sweet potato, tomato, watermelon, and winter squash
- Changes in PHIs for many older insecticides

Fertilizer Recommendations

Recommendations for phosphorus (P_2O_5) and potassium (K_2O) fertilization given in this publication are based on soil test levels. Recommendations based on a soil test may be obtained from your state soil testing lab or the Cooperative Extension Service.

Recommendations for nitrogen (N) given in this publication should be adjusted to account for soil type, cropping history, additions of organic matter, and crop culture system used. For example, for soils with more than 3% organic matter and following soybeans, alfalfa, or a grass-legume hay crop, no sidedressed N may be needed. For soils with less than 3% organic matter and the above rotation, 1/2 of the total N can be applied preplant and the other 1/2 sidedressed early in the crop growth cycle. Where the vegetable crop is following corn, rye, oats, wheat, or a previous vegetable crop, there may be no residual soil N available and additional sidedressed N may be of benefit.

Crops that are transplanted, such as cabbage, broccoli, tomatoes, peppers, and melons, often respond to a small amount of water soluble fertilizer in the transplanting water. Special fertilizer grades are used at a rate of 3 pounds per 50 gallons of water. Examples are 14-28-14, 10-52-10, and 23-21-17. The high phosphorus liquid 10-34-0 can also be used at the rate of 2 quarts per 50 gallons of water. Apply the starter solution at 0.5 pint (8 oz.) per plant. If dry weather is prevalent, irrigate after setting the plants.

pH and Lime

Maintaining mineral soil at a soil pH 6.0 to 6.8 and organic soil at a soil pH 5.5 to 5.8 is recommended for most vegetable crops. Soil pH should be adjusted **only** on the basis of a soil test, which should be conducted routinely. If your soil has little natural buffering capacity, low clay content, and low cation exchange capacity (CEC), then annual soil tests are recommended. Such sandy soils include those found along the Wabash, Illinois, Kankakee, Cedar, Iowa, and Mississippi Rivers.

Low pH (or acid) soils can be a significant problem in most vegetable-producing regions. Vegetables grown under acid soil conditions lack vigor and yield poorly. Under severe conditions, visible injury on the foliage can occur as a result of magnesium deficiency and/or manganese toxicity. The problem can be easily prevented and corrected for the next crop by a proper lime application based on soil analysis. Magnesium deficiency in low pH soils can best be corrected by an application of dolomitic limestone. Be sure to inquire about the magnesium content in the limestone.

Sources of magnesium, other than dolomitic lime, are the soluble salts potassium-magnesium sulfate (11% magnesium) or Epsom salts (10% magnesium). Apply one of these products according to the soil test level in the table below.

Magnesium Soil Test (ppm) MN		Relative Level	Magnesium to Apply Broadcast ---lb./A---	Row
0-39	0-50	low	100	20
40-69	51-100	medium	50	10
70+	100+	high	0	0

MN = Minnesota

Soil Sampling and Analysis

Soil samples for testing should be representative of the field, because large variations in soil pH can occur in a given field. Instructions for taking soil samples are available at your county Extension office.

Soil samples should be taken at the same time of the year, preferably fall or early spring. Soil pH will vary seasonally, making comparisons between winter and summer samples difficult. Samples can be analyzed for pH, lime index, available Bray P1 phosphorus, exchangeable potassium, calcium, magnesium, sulfur, micronutrients, CEC, color, and texture. The lime index determines the tons/acre of lime required for the field. The lime recommendation should be broadcast and worked into the entire plow layer. In addition to the routine water pH test, soils that are susceptible to large variations in soil pH should be tested for salt pH. The pH (salt) provides a more accurate estimate of the true acidity in these soil types by simulating the effects of fertilizer salts on soil pH.

Transplant Production

Transplant production has replaced direct seeding for many vegetable crops. One of the primary advantages offered by transplanting is earlier fruit production, allowing growers to capture better market conditions. In addition, the high cost of hybrid seed makes it desirable to use each seed as efficiently as possible. Transplanting also gives the crops a competitive advantage against weeds. This section addresses the special skills and knowledge required for successful transplant production.

Greenhouse

Most growers use polyethylene-covered greenhouse structures to provide warmth and protection from the environment. Although cole crops do not need the more moderating conditions a greenhouse provides, they can be grown in coldframes, lean-tos, or covered wagon beds.

The heater is one of the most critical features of a transplant greenhouse. Vegetable transplants must be kept at the appropriate temperatures. However, if heaters are improperly exhausted, the transplants can be stunted or deformed. To prevent heater fumes from returning into the greenhouse, chimneys vented out of the top of the house should extend 2 feet above the ridge.

There should be some provision for bringing fresh air into the greenhouse. Some heaters vent fresh air into the greenhouse every time the furnace operates. For others, a hole or holes should be cut in the greenhouse wall and fitted with a tube to feed outside air to the heater. Avoid space heaters that may "spit" diesel or gasoline onto nearby plants. Heated air should be circulated using a perforated "sock" or tube that runs the length of the greenhouse, or fans that are placed on opposing sides of the greenhouse and blow in opposite directions. Temperature at plant level should be monitored by placing thermometers in several locations. At least one high-low thermometer is a good investment.

For detailed information on greenhouse structures, write to: Northeast Regional Agricultural Engineering Service, 152 Riley-Robb Hall, Cooperative Extension, Ithaca, NY 14853-5701. Ask for the publication titled, Greenhouse Engineering, NRAES-33.

Transplant Containers

A wide variety of transplant containers are available, each with advantages and disadvantages. The most common ones are: 1) Todd planter trays made of Styrofoam (Speedling type), 2) polystyrene or PVC flats or trays, and 3) Peat strips, pots or pellets (e.g., Jiffy).

The peat pot type containers have the advantage that the root system need not be disturbed upon planting. This is important in crops such as cucurbits that are sensitive to root disturbance. Peat pots are more forgiving of over watering than the other containers. However, peat pots have to be reordered every year. If peat pots are planted partially above ground, moisture is "wicked" away from the plant, often resulting in plant death. (Peat pellets do not have this disadvantage.)

The polystyrene and Todd planter flat are both designed so that the transplant must be "popped" out of the tray, thus disturbing the root system. This is particularly true if the roots are allowed to grow into the ground beneath the tray. Avoid this problem by placing a plastic sheet on the ground. Both the polystyrene and Todd planter flats must be watered with care. The Todd planter flat has a pyramidal design that forces roots downward to an open bottom where the roots are air pruned. Some polystyrene containers have open bottoms as well. (Tube type have open bottoms, groove type have small drainage holes.) An advantage of the polystyrene and Todd planter flats is that they may be used for several years. In general, peat type containers are the most expensive, followed by the Todd planter type, and then by the polystyrene type.

The number of plants in a tray depends on the cell size for each plant. Vegetables are commonly grown in trays with 30 to 300 cells. In general, larger cells lead to greater early yield in fruiting crops. Larger cells are also easier to manage because the greater soil volume holds more water and nutrients. Due to the expense of building and maintaining greenhouse space, many growers have moved to smaller and smaller cell volumes so that more transplants can be grown in the limited space available. Some growers use two different cell sizes, the larger cell size for the crops they expect to harvest earlier, and the smaller cell size for crops they expect to harvest later.

Seeding and Growing

Most vegetable transplants are sown one seed per cell. As a general rule, plant vegetable seeds at a depth two times their diameter. Vegetable seeds vary in their temperature requirements; most vegetable seeds germinate in the 70 to 90 ° F range. The time from seeding to transplanting varies from 3 to 4 weeks (e.g., muskmelon) to 10 to 12 weeks (e.g., celery). Vegetable seed may be ordered with special features, including seed priming and pelletizing. Primed seed have been partially hydrated and then dried down, resulting in earlier germination and better uniformity. Priming may be

useful for hard-to-germinate seed such as triploid watermelon. Seed may be pelletized to make it easier to handle. In this process, varieties with small seed or irregular seed such as lettuce are coated to make the seed larger and uniform in size and shape. This process makes mechanized planting easier.

The growing mix should be well-drained and free of disease-causing organisms (pathogens). Most commercial mixes fit this description and perform well. These mixes are often referred to as "soilless mixes" since they are composed primarily of peat or coconut coir, perlite or vermiculite, and sometimes bark or ash. These mixes usually come in bales or bags and have been pasteurized (sufficiently heated to kill soil microorganisms capable of causing disease problems). It is advisable to test the mix before using it to make sure the pH is within an acceptable range (5.5 to 6.5) and to determine the initial nutrient content of the mix.

Most mixes include a small amount of fertilizer, but transplants usually benefit from additional regular fertilization with N, P, and K once true leaves appear. Depending on the initial nutrient level in the mix, including Ca and Mg in the fertilizer solution may also be advised. Soluble synthetic fertilizers (21-5-20, 20-10-20) and liquid organic fertilizers (fish emulsion) are commonly used. The best rate, frequency, and method of fertilization will depend on your potting mix and watering practices. Common alternatives include a 50 to 200 ppm N solution applied at every watering or a 300 to 500 ppm N solution applied weekly. To make a 100 ppm N solution, use 0.42 lb. (6.6 oz.) of a 20% nitrogen fertilizer for 100 gallons of water. Over-application of nitrogen in the ammoniacal form can be detrimental to transplants. This problem can be minimized by not over-applying N and by using fertilizer that contains most N in the nitrate form. Check the bag label.

Transplants that are too tall and tend to fall over are often referred to as "spindly," "shanky," or "leggy." Such transplants may have low survival rates in the field. Spindly transplants are produced under low light conditions, high fertilizer rates, and/or overwatering. Greenhouse structures that let inadequate light in or cloudy weather could be the culprits. Artificial lights could be helpful during inclement weather, but may be cost prohibitive. Use a fertilizer containing a lower percentage of P. For instance, try 21-5-20 rather than 20-20-20. It is important to provide adequate P, but not too much. Underfertilization with P will produce short plants, but yields will also suffer. Hot days and cold nights favor leggy transplants. If night temperatures are equal to or higher than day temperatures, stem elongation will be reduced. It may be sufficient to lower the temperatures for a two-hour period starting at dawn.

To prepare transplants for the harsher environment of the field, it is necessary to harden them off. Transplants may be hardened off by withholding water and lowering the temperatures moderately during the last week or so of growth. Some growers place transplants in wagons and wheel the transplants outside on appropriate days to get the plants used to field conditions. The transplants are wheeled back inside during nights and especially harsh weather.

Transplants should be irrigated as soon as possible after transplanting. Some transplanters are equipped to irrigate transplants at the time of transplanting. Otherwise, arrange to irrigate soon. Applying a small amount of starter fertilizer in the transplant water is often beneficial. See Fertilizer Recommendations, p. 3, for starter fertilizer recommendations. If transplants are held in the greenhouse to replace those that don't survive, remember to avoid using transplants that have begun to vine or flower.

Diseases

Diseases that are likely to affect vegetable transplant production in Midwest fall into two types: damping-off diseases caused by soilborne fungi and transplant diseases usually associated with fungi or bacteria which survive with seed or plant residue. Both types of diseases can cause extensive transplant loss.

Damping-off may occur before or after seedlings emerge from the soil. Pre-emergence damping-off occurs when fungi infect seeds as they germinate. As infection progresses, seeds rot and eventually disintegrate. Poor stands become apparent several days or weeks later.

Post-emergence damping-off is usually observed in seed flats or among transplants. Fungi infect stems at or near the soil surface. The affected area of the stem takes on a water-soaked appearance and sometimes becomes constricted. Eventually, the stems are unable to maintain structural support of seedlings, which usually collapse and die within 24 to 48 hours.

Damping-off can be caused by any or all of three groups of soil borne fungi, *Pythium*, *Rhizoctonia*, and *Fusarium*.

The following are control measures to prevent damping-off diseases.

- Use uncontaminated soil mix. Use a commercially prepared soilless growing mix sold in 3-4 cu. ft. bales or bags. A common mistake is to open a bag of "clean" soil mix and place it on a dirty floor or some other unclean surface prior to planting. Remember that your soil is only as clean as the dirtiest surface with which it has come into contact.
- Plant seeds shallow and in warm soil.
- Use soil mixes that drain well.

Table 1. Vegetable crops frequently grown as transplants and the diseases that are most often observed on the seedlings. The pathogens that cause these diseases may be borne on the seed.

Vegetable Crop	Disease
cabbage	black rot Alternaria leaf spot
cucumber	angular leaf spot
muskmelon	anthracnose gummy stem blight
pepper	bacterial spot
tomato	bacterial canker bacterial speck bacterial spot
watermelon	anthracnose gummy stem blight watermelon fruit blotch

Seedborne/residueborne diseases affect most vegetable crops. The pathogens (disease-causing microorganisms) that cause these diseases survive in seeds or plant residues, not in soil mixes. Outbreaks of these diseases often show up as clusters of diseased plants. Symptoms often include brown lesions with yellow halos on leaves. In contrast, environmentally induced problems often occur uniformly throughout the seedlings or only in one location (for example, close to an outside wall).

Several different fungal or bacterial pathogens may be introduced into a transplant facility via contaminated seed or transplants (Table 1). Once introduced, these pathogens may continue to cause problems year after year if proper precautions are not taken.

Several measures should be taken to minimize or prevent the introduction of a seedborne/residueborne pathogen into a transplant facility.

- Avoid saving seed unless you are specifically trained and equipped for seed production.
- Frequently inspect seedlings as they are growing.
- Separate seedlots from one another. Save all information regarding seed purchases.
- Irrigate in the morning to ensure drying of soil and leaf surfaces.
- Check the label for specific mention of greenhouse use when treating transplants with fungicides/bactericides.
- Use good sanitation. Plant pathogens often survive in soil and plant residues. Therefore, sanitation is as important for a greenhouse as it is for a kitchen. Greenhouse floors should be as free of soil and residue as possible; plastic or cloth floor coverings provide a barrier between dirt floors and transplants. Transplant trays and flats should be new or cleaned and disinfected before each transplant generation.

Growers who want more detailed information on disease prevention and control in the greenhouse may refer to the Purdue Extension publication "Preventing Seedling Diseases in the Greenhouse," <www.agcom.purdue.edu/AgCom/Pubs/BP/BP-61/BP-61.html>.

Use of Plastic Mulch

Black plastic mulch laid before planting aids in weed control, reduces root pruning, and gives profitable increases in early yields of warm-season crops. Wavelength-selective and clear mulches typically lead to greater early yields than black plastic, but weed growth under the mulches may be a problem. This is particularly true for clear mulch. Because leaching is retarded, less fertilizer is lost, and nitrogen sidedressing is often unnecessary with the plastic mulch. If nitrogen needs to be added, it can be applied later through the irrigation system.

Try to lay the plastic as early in the season as possible, such as from mid to late April. It should be laid as soon as the ground can be worked after a heavy rain. Plastic mulch should be laid over moist soil. If the plastic is laid over dry soil, it will actually delay subsequent transplant growth. It is better that the plastic be laid at midday so that it can be stretched tight. Do not overstretch because cool nights may actually cause the plastic to tear.

The seedbed should be as fine as possible so you can get a good covering; rototilling is preferred. The plastic is laid by burying about 6 inches of each edge.

A disadvantage of plastic mulch is disposal at the end of the season. Many landfills do not accept plastic mulches. Photodegradable plastic mulches are available. They degrade into small pieces of plastic that remain in the environment. Biodegradable plastic mulches are not yet widely available.

Irrigation and Water Management

Vegetables require an adequate supply of moisture throughout their entire growth. While the frequency and amount of water may vary depending on the individual vegetable crop, the age of the crop, current soil moisture, and type of soil and weather conditions, generally 1 to 1.5 acre inches of water are required each week.

Effective Rooting Depth of Selected Vegetables

Shallow (6-12")	Moderate (18-24")	Deep (> 36")
Beet	Cabbage, Brussels Sprouts	Asparagus
Broccoli	Cucumber	Lima Bean
Carrot	Eggplant	Pumpkin
Cauliflower	Muskmelon	Squash, Winter
Celery	Pea	Sweet Potato
Greens & Herbs	Pepper	Watermelon
Onion	Potato	
Radish	Snap Bean	
Spinach	Squash, Summer	
	Sweet Corn	
	Tomato	

	Crop*	Most Critical Period
1.	broccoli, cabbage, cauliflower, lettuce	head development
2.	carrot, radish, beet, turnip	root enlargement
3.	sweet corn	silking, tasseling and ear development
4.	cucumber, eggplant, pepper, melon, tomato	flowering, fruit set, and maturation
5.	bean, pea	flowering, fruit set, and development
6.	onion	bulb development
7.	potato	tuber set and enlargement

*For transplants, transplanting and stand establishment represent a most critical period for adequate water.

The total available water holding capacity (AWHC) for a given location depends on the soil texture, organic matter, and rooting depth. Irrigations should be initiated for most crops before 50 percent of the available water is removed by the plants in the active root zone. A majority of the roots for most vegetable crops, however, are usually within the top 6 to 18 inches. AWHC estimations are best obtained from the county soil survey or the local Soil and Water Conservation District office. **Table 1** shows AWHC estimations for some typical soil textures in the upper Midwest.

Table 1. Available Water holding Capacities for Several Soil Types

Soil Texture	Available Water Holding Capacity	
	Inch Per inch of Soil	Inch Per Foot of Soil
Loamy fine sand	.08 - .12	0.96 - 1.44
Sandy loam	.10 - .18	1.20 - 2.16
Loam	.14 - .22	1.68 - 2.64
Silt loam	.18 - .23	2.16 - 2.76
Clay loam	.16 - .18	1.92 - 2.16

Soil Water Monitoring

Two common ways of estimating soil water deficit to assist an operator in irrigation scheduling are (1) soil water tension with soil moisture sensors and (2) the feel and appearance method with the soil probe.

Soil water tension can be monitored at a given point in the active root zone by electrical resistance moisture blocks or tensiometers. Soil tension or suction is a measurement usually expressed in centibars that describes how tightly water is held to the soil particles.

If the soil texture is known, the amount of soil water deficit for a given tension reading can be estimated by the use of **Table 2**. Tensiometers directly read soil tension between 0 and 80 centibars and work best in sandy loam or lighter textured soils. Resistance blocks work in a wider range of soil textures, and some types work as well in lighter textured soils, as do tensiometers.

To obtain representative soil tension readings with any sensor, the sensors should be left installed throughout the irrigation season and preferably at two or more locations in the field. Two depths are generally desired at each location. These depths should be about one-third and two-thirds of the active root zone or at around 6 and 12 inches.

The **feel/appearance** method involves collecting soil samples in the root zone with a probe or a spade. The soil water depletion of each sample can be estimated by feeling the soil and comparing its appearance to the description in **Table 3**. Soil samples should be taken from the top six to 12 inches in the root zone and at several locations in the field. Sum up the estimations from various depths for one location to estimate the total soil water depletion in the root zone. The operator must use this method frequently in order to perfect the art of consistently estimating soil water.

More information on in-field soil moisture monitoring tools may be obtained from your local county Extension office.

Table 2. Soil Water Deficit Estimates for Different Soil Textures and Selected Tensions

Soil Texture	Soil Tension in Centibars						
	10	30	50	70	100	200	1500*
	Soil Water Deficit - Inches Per Foot of Soil						
Coarse sands	0	0.1	0.2	0.3	0.4	0.6	0.7
Fine sands	0	0.3	0.4	0.6	0.7	0.9	1.1
Loamy sands	0	0.4	0.5	0.8	0.9	1.1	1.4
Sandy loam	0	0.5	0.7	0.9	1.0	1.3	1.7
Loam	0	0.2	0.5	0.8	1.0	1.6	2.4

*1500 cbs refers to the permanent wilting point and the soil deficit value is equal to the soil's total available water capacity

Table 3. Guide for Judging Soil Water Deficit Based on Soil Feel and Appearance for Several Soil Textures

	Soil Texture Classification			
Moisture deficiency in./ft.	Coarse (loamy sand)	Sandy (sandy loam)	Medium (loam)	Fine (clay loam)
.0	(field capacity) Leaves wet outline on hand when squeezed.	(field capacity) Appears very dark. Leaves wet outline on hand. Makes	(field capacity) Appears very dark. Leaves wet outline on hand. Will	(field capacity) Appears very dark. Leaves slight moisture on hands
.2	a short ribbon. Appears moist. Makes a	ribbon out about one inch.	when squeezed.	Will ribbon out about two in.
.4	weak ball. Appears slightly moist. Sticks together slightly.	Quite dark color. Makes a hard ball.	Dark color. Forms a plastic ball. Slicks when rubbed.	Dark color. Will slick and ribbons easily.
.6		Fairly dark color. Makes a good ball.		Quite dark. Will make thick ribbon. May slick when
.8	Appears to be dry. Will not form a ball under pressure.	Slightly dark color. Makes a weak ball	Quite dark. Forms a hard ball.	rubbed.
1.0		Lightly colored by moisture.	Fairly dark. Forms a good ball.	Fairly dark. Makes a good ball.
1.2	Dry, loose, single-grained. Flows through fingers. (wilting point)	Will not ball.	Slightly dark. Forms weak ball.	Will ball. Small clods will flatten out rather than crumble.
1.4		Very slight color due to moisture. Loose. Flows through fingers. (wilting point)	Lightly colored. Small clods crumble fairly easily.	Slightly dark. Clods crumble.
1.6				
1.8			Slight color due to moisture. Powdery. Dry. Sometimes slightly crusted but easily	Some darkness due to unavailable moisture. Hard, baked. Cracked. Sometimes
2.0			broken down in powdery condition. (wilting point)	has loose crumbs on surface. (wilting point)

Chemigation Management

Chemigation is the process of applying an agricultural chemical (pesticides or fertilizers) to the soil or plant surface with an irrigation system by injecting the chemical into the irrigation water. Depending on the type of agricultural chemical being applied, chemigation may be referred to as herbigation, insectigation, fungigation, fertigation, etc.

Only pesticides displaying product EPA label approval for application through an irrigation systems can be applied by chemigation. Also, each chemigation and irrigation system must use the required safety equipment specified in the EPA label as well as any listed in the user's respective state codes. Some states may also require a system or operator permit before chemigation can be used to apply any product.

Chemigation can be an effective application option for some labeled pesticides if the irrigation system can apply the chemical/water solution uniformly over the target area with the correct water depth. Some pesticides work best with less than .25 inch of water per application. Most late model center pivot and linear move systems provide adequate distribution but some may not be able to apply a small enough water depth. Solid set sprinkler systems may be effective for some pesticides but requires close timing of chemical movements to get complete and uniform coverage of the field. Traveling gun and hand move systems do not provide water distribution that has high uniformity and are not recommended. Drip systems apply water to only the soil and within a limited area so are not recommended for most pesticide products. Further information on appropriate water application amounts and which irrigation systems are recommended can be found on product label.

Chemigation creates the potential for the injected chemical to backflow into the water source when the irrigation pump shuts down if proper check valves and interlocks are not in place or maintained. EPA and many state regulations specify that each system must contain a reduced pressure zone (RPZ) backflow prevention valve or one or two independent check valves with low-pressure drains and vacuum relief valves between the irrigation water source and the point of chemical injection. Also, most regulations require a power interlock between the irrigation pump and the chemical injector unit, a low pressure shut down switch and a check valve on the chemical injection hose. For specific requirements, check with the appropriate local or state agency.

Accurate calibration of the irrigation system and the pesticide application rate is most important. The chemigation operator must be aware of the irrigation system's speed of application (acres per hour) for the chosen water application amount and the concentration of chemical solution to determine the rate of chemical injection. A step-by-step procedure on how to determine the system's speed application and chemical injection rate is described in the MidWest Planning Service (MWPS) handbook #30 *Sprinkler Irrigation Systems* which is available from any state Extension distribution office accessible on the internet at <http://www.bae.umn.edu/extens/mwps/index.html>. Another source of discussion of the special equipment, operations and calibration is the University of Minnesota Extension Service bulletins AG-FO-6122 *Chemigation Safety Measures* and AG-FO-18 *Nitrogen Application with Irrigation Water* which are accessible on the internet at <http://www.extension.umn.edu/>.

Approximate Time from Pollination to Market Maturity Under Warm Growing Conditions

Vegetable	Days to Market Maturity
Bean	7-18
Corn, market	18-23*
Corn, processing	21-27*
Cucumber, pickling (3/4 - 1 1/8 inch in diameter)	4-5
Cucumber, slicing	15-18
Eggplant (2/3 maximum size)	25-40
Muskmelon	40-50
Okra	4-6
Pepper, green stage (about maximum size)	45-55
Pepper, red stage	60-70
Pumpkin, Jack-o-lantern	60-90
Pumpkin, Baking	65-75
Squash, summer, Zucchini	3-4**
Squash, winter, Butternut	60-70
Squash, winter, Hubbard	80-90
Squash, winter, Table Queen or Acorn	55-60
Tomato, mature green stage	35-45
Tomato, red ripe stage	45-60
Watermelon	40-50

* From 50% silking.

** For a weight of 0.25-0.5 lb.

Yields of Vegetable Crops

Crop	Expected Yields in Tons per Acre		
	Average	Good	Excellent
Asparagus	1	1-2	2
Bean, snap	2	4	5
Cabbage	13	15	20
Corn, sweet	3	8	10
Cucumber, slicing	4	12	15
Cucumber, pickling, hand harvest	7	10	12
Muskmelon	8	12	16
Onion	15	20	25
Pepper, green	5	10	13
Potato (fall)	10	15	20
Tomato, fresh market	6	13	15
Tomato, processing	25	30	35
Watermelon	15	20	25

Postharvest Handling and Storage Life of Fresh Vegetables

Careful attention should be given to the postharvest handling and storage of fresh market vegetables. Lack of adequate refrigeration and cooling will result in a shortened shelf-life and lower quality of the fresh vegetable. The following list of recommended storage condition information has been modified from USDA's Agricultural Handbook No. 66 and Maynard and Hochmuth's *Knott's Handbook for Vegetable Growers*.

	Storage Conditions		
Vegetable	Temperature (°F)	Relative Humidity (%)	Relative Storage Life
Broccoli	32	95-100	10-14 days
Cabbage, late	32	98-100	5-6 months
Cauliflower	32	95-98	3-4 weeks
Corn	32	95-98	2-5 days
Cucumber	50-55	90-95	10-14 days
Muskmelon	36-41	95	10-15 days
Watermelon	50-60	90	2-3 weeks
Pepper, green	45-55	90-95	2-3 weeks
Pepper, ripe	42-45	90-95	1 week
Potato, early	Note [1]	90-95	Note [1]
Potato, late	Note [2]	90-95	Note [2]
Pumpkin	50-55	50-70	2-3 months
Squash, winter	50-55	50-70	Note [3]
Sweet potato	55-60	85-90	5-6 months
Tomato, mature-green	55-62	90-95	1-2 weeks
Tomato, firm-ripe	45-50	90-95	4-7 days

[1] Most summer-harvested potatoes are not stored. However, they can be held 4-5 months at 40°F if cured 4 or 5 days at 60-70°F before storage. They can be stored 2-3 months at 50°F without curing. Potatoes for chips should be held at 70°F or conditioned for best chip quality.

[2] Fall-harvested potatoes should be cured at 50-60°F and high relative humidity for 10-14 days. Storage temperatures for seed or table stock should be lowered gradually to 38-40°F. Potatoes intended for processing should be stored at 50-55°F. Those stored at lower temperatures or with a high reducing sugar content should be conditioned at 70°F for 1-4 weeks or until trial cooking tests are satisfactory.

[3] Winter-squash varieties differ in storage life. Table Queen squash can be stored for 35-55 days; Butternut, 60-90 days; Hubbard, 180 days.

Care should be taken not to keep the temperature too low. Cucumber, eggplant, lettuce, sweet pepper, potato, snap bean, squash, and tomato are among the most susceptible vegetables to chilling or freezing injury. Some of the typical symptoms of cold injury that can make the vegetables unmarketable include pitting, water-soaked spots, browning, surface decay, and failure to ripen in peppers and tomatoes.

Farm Labor Law Information

To obtain information about the Immigration and Reform Act and current related farm/labor laws that specify employer responsibilities and seasonal agricultural worker status, contact:

Federal: Office of Special Counsel, Washington, D.C., Employer Information: (800) 255-8155.

In Illinois: Travel Control Section, Immigration and Naturalization Service, 10 W. Jackson, Chicago, IL 60604, (312) 353-7334.

(Migrant Farm Workers and Farm Labor) Department of Labor, 310 S. Michigan Ave., Chicago, IL 60604, (312) 793-2804.

In Indiana: Immigration and Naturalization Service (INS). John Klemme, Officer in Charge, 950 N. Meridian Street, Indianapolis, IN 46204, (317) 226-6009.

Migrant Farmworkers Project. Nancy Hale, Director, 151 N. Delaware Street, Suite 1800, Indianapolis, IN 46204, Toll-free: (800) 869-3505 (farm workers only) or (317) 631-9410 ext. 236.

In Iowa: Iowa Dept. of Employment Services, Attn: John McDonald, Bureau of Field Operations, 150 Des Moines St., Des Moines, IA 50309, (515) 281-9336.

In Minnesota: Immigration and Naturalization Service (INS), 2910 Metro Dr., Bloomington MN 55425, (612) 854-7754, after hours: (612) 222-8824.

Minnesota Labor and Industry Dept., 443 Lafayette Rd., St. Paul, MN 55155, (612) 296-6107.

In Missouri: Missouri Dept. of Economic Development, Division of Workforce Development, 421 E. Dunklin St., P.O. Box 59, Jefferson City, MO 65104, (573) 751-3978.

Precautions with Pesticides

Pesticides are designed to poison or otherwise manage pests. Many pesticide products may poison people, pets, livestock, wildlife, ornamental plants, and other non-target organisms. Pesticide applicators and their families have increased potential to be exposed to pesticides. It is important to keep all pesticide exposures to an absolute minimum.

You must protect your family members, field workers, and other people from pesticide injuries. Most pesticide accidents result from careless practices or lack of knowledge about safe handling of pesticides. The time you spend to learn about the safe use of pesticides is an investment in the health and safety of yourself, your family, and others.

The Environmental Protection Agency has certain restrictions on the use of pesticide chemicals. These restrictions apply to the use of chemicals applied to control insects, mites, plant diseases, weeds, nematodes, and other pests. Such restrictions may prohibit the use of a chemical or allow residue tolerances on harvested vegetables. A grower must know what chemical to use on each vegetable; how to apply; the post-treatment re-entry interval, if any; when to use the chemicals with respect to farm worker and/or picker safety; and the environment and the harvest of each vegetable crop. The grower must follow all label instructions regarding harvest restrictions (1) to assure the consumer that the food is free of dangerous residues and (2) to comply with the law to prevent seizure of his crop.

- Only mix the amount of a pesticide that you can use in one day.
- If you do have leftover spray mix, the best way to dispose of it is by applying it to a labeled crop in a legal manner.
- Never dispose of surplus pesticides in a way that will result in the contamination of ground or surface waters.
- Rinse all empty containers three times before disposal.
- Pour the rinse water into the spray tank. Puncture or break triple-rinsed containers to facilitate drainage and to prevent reuse for any other purpose.
- Then dispose of the container according to label directions.

Rules For Using Pesticides with "Danger" Signal Word

Formulations of Monitor, Lannate, Thimet, DiSyston, Furadan, and Guthion are highly poisonous. They should not be applied unless applicators strictly follow all precautions listed on the pesticide label. Some of those listed are the following.

- When handling or applying these materials, always wear the proper respiratory equipment as listed on the label.
- Always wear protective clothing to cover as much of the body as possible.
- Never handle pesticides with your bare hands. Wear rubber gloves, not leather or cloth gloves.
- Avoid breathing these pesticides when opening the containers or mixing into the spray tanks.
- Always wash hands, arms, and face immediately after handling pesticides and before eating or smoking. Never smoke while handling or applying pesticides.
- During the spraying operation, work in a manner to reduce all possible hazards of coming into direct contact with spray drift. In fact, if wind conditions make it difficult to stay out of the drift, don't spray. If you must spray, wear all protective clothing as listed on the pesticide label.
- After each day's work, take a thorough shower or bath, and change clothes. Wash spray clothes separately from the family wash, and after washing clothes, run another complete hot water and detergent wash cycle through the washer before washing family clothes.
- Wear clean overalls, underwear, socks, and cap each day you spray.
- Always keep pesticides in their original labeled containers, and store in a safe place. Store and dispose of containers according to information on the pesticide label.

Symptoms of Pesticide Poisoning

Poisoning symptoms include headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Symptoms can begin almost immediately after exposure or may be delayed for several hours. Call a physician any time you are concerned about illness due to contact with a pesticide.

If you experience any of these symptoms during exposure to pesticides, stop spraying or dusting immediately, and have someone take you, or go yourself, to a doctor. Do not resume spraying or dusting until you have consulted a doctor and the tests show it is safe to continue. When going to the doctor, take along the pesticide label or a sample label of the pesticide you have been using, material safety data sheet, and, if possible, the phone number of the manufacturer. This information is extremely critical for the doctor to make a proper diagnosis.

Emergency Treatments

Medical antidotes should be prescribed or given only by a qualified physician. First aid treatments should be given by someone having a basic knowledge of first aid as it relates to pesticide poisoning. In advance, prepare a well-thought-out plan of action to follow in the event of an accident with pesticides! First aid can be used initially to help a victim while medical help is on the way, or can be administered to a victim enroute to qualified help.

Call a doctor, an emergency medical service, or an Area Poison Information Center for immediate help. Know whether the label has a telephone emergency information number printed on it. **Poison Information Centers have been established in Illinois, Indiana, Iowa, Minnesota, Missouri, and surrounding states to provide physicians with current information on diagnosing and treating accidental poisoning cases.** See the inside front cover of this publication for poison control information for your state.

In case of accidental poisoning, first call a physician or hospital. Give them information about the poisoning, especially the name of the pesticide product. If they do not have a poison information center there, they should be able to put you in contact with the nearest one. If not, consult your local hospital, and get the name, address, phone number, and director of the center nearest you. You should get this information now just to have it available should the need arise.

Use of Bees with Vegetable Crops

In most vegetable plants, seed or fruit development depends on pollination and fertilization. In most cases, this involves the transfer of pollen from the male portion of the flower to the female portion. Pollen is also used as a source of protein by a wide spectrum of insects. It is especially important to bee species specializing in pollen collection. In the process of collecting this valuable food source, these insects provide the pollen transportation link that many plants need for reproduction. A single honey bee can carry up to five million pollen grains on its body, and a strong honey bee colony may bring in well over 50 pounds of pollen during a season.

Other factors influence the honey bee's role as the pollinating leader. Only honey bees are significantly socially developed to overwinter as a colony. This is the key element that makes it possible for humans to manage honey bees. Populations of naturally occurring bee species have been declining for the last few decades. This may be due to a number of factors, including the reduction of natural habitats, parasitic mites, brood diseases, and pesticide use.

At least 90 crops grown in the United States depend to some extent upon bees as pollinators, either for seed or fruit production. The exact number of hives needed will depend on a number of factors, including strength and condition of colonies, magnitude of the natural pollinator community, amount of wild flower material competing with the crop, attractiveness of the crop to bees, projected yield, and the weather. The following are guidelines for the number of hives to use when supplemental pollination is desired:

cucumber	(2 to 3 colonies per acre)	squash	(1 colony per acre)
muskmelon	(2 to 3 colonies per acre)	watermelon	(1 to 2 colonies per acre)
pumpkin	(1 colony per acre)		

The following vegetables will set fruit without bees, but bee activity has shown to increase yields:

eggplant lima bean okra pepper

Honey bees do not assist in the pollination of the following crops, but will collect pollen and nectar from them:

peas snap bean sweet corn tomato

Many growers currently purchase pollination services from beekeepers for their vegetable fields. To ensure mutual satisfaction of both grower and beekeeper, a pollination contract should be signed by both. The following points should be considered in the contract: rental price, number of colonies, strength of colonies, timing of placement in the fields and removal from fields, field location, responsibility for maintenance of the colonies, access for the beekeeper to the hives, liability for stings, and protection from pesticides.

Generally, a grower should require that any hive he rents for pollination should have two deep supers (boxes), a good egg-laying queen, at least 4 to 5 frames of brood, and 20+ pounds of surplus honey, and be disease free. Hives should only be placed in fields after some of the crop's flowering has begun. If hives are placed before there are available flowers, bees will forage in surrounding areas and may not return to pollinate the flowers of the intended field. Also, when planning where to place the hives, growers should remember that honey bees usually pollinate flowers most thoroughly within 100 yards of their colony, although if forced to, they will travel much farther. Thus, hives should be distributed in groups throughout the field rather than in a single location, with convenience to the beekeeper in mind as well as uniform pollination.

Certain pesticides and pesticide application practices pose a serious hazard to honey bees. In general, applications made at night pose the least hazard to bees, with applications made in early morning second best. The application of a single pesticide is usually less dangerous than applying combinations. Systemic insecticides are usually very safe to bees, as are granular formulations. Emulsifiable or water soluble formulations are safer than wettable powders of the same material. The list on page 15 classifies insecticides by the degree of toxicity to honey bees. A list of chemicals and methods of application that are mutually agreeable to the grower and beekeeper may be added to the pollination contract.

For protection of the honey bees and his own liability, a grower should work closely with the beekeeper in developing a program regarding pesticide application scheduling and application.

Use of Bees with Vegetable Crops (cont.)

Highly Toxic Insecticides

Severe bee losses can be expected if the following materials are used when honey bees are present at treatment time or within a day thereafter.

Ambush, Ammo, Asana, Baythroid, Diazinon, Dibrom, Dimethoate, Furadan, Fury, Guthion, Imidan, Lannate, Lorsban, Malathion, Monitor, Mustang, Orthene, Penncap-M, Pounce, Scout X-Tra, Sevin, Warrior

Moderately Toxic Insecticides

These can be used in the vicinity of honey bees if the dosage, timing, and method of application are correct. However, they should not be applied directly on honey bees in the field or at the hives.

Admire, Di-Syston, Metasystox R, Provado, Thiodan, Thimet, Vydate

Relatively Non-Toxic Insecticides and Acaricides

This group of materials can be used around honey bees with a minimum of injury.

***Bacillus thuringiensis* (MVP, Dipel, Javelin, Agree, Biobit, Lepinox, M-Trak, etc.), Adios, Kelthane, Methoxychlor, Omite, Pyrethrum, Rotenone**

Re-entry Standards/Worker Protection

EPA's revision of the Worker Protection Standard is "...designed to reduce the risk of illness or injury resulting from workers' and pesticide handlers' occupational exposures to pesticides used in the production of agricultural plants on agricultural establishments...." After April 21, 1994, all products covered by the rule must bear the WPS. The actual Worker Protection Standard that will be referenced on the pesticide label is 15 printed pages. It covers workers who are in contact with pesticides, workers who handle pesticides, or workers who are employed in the production of agricultural plants on four types of establishments -- farms, forests, nurseries, and greenhouses.

Pesticide Safety Training. Training instructions will have to be provided on a five-year cycle. The pesticide safety training that employers will provide their workers will include information on routes of entry, symptoms of poisoning, and emergency first aid. Those workers handling pesticides will need additional training on label interpretation, environmental impact from drift and runoff, wildlife hazards, and pesticide handling.

Pesticide Safety Information. Employers will establish a central location, accessible to all workers and handlers, for displaying pesticide information: a pesticide safety poster, emergency medical care information, and basic pesticide safety concepts.

Application Notification. Workers will be notified of specific locations where pesticides have been applied, as well as any re-entry restrictions that may apply. Depending on the particular pesticide product, notification may be oral or written and may require posting.

Entry Restrictions. Workers not involved in the application will not be permitted to enter or remain in an area being treated. Under no circumstances may early-entry workers enter a treated area until at least four hours following completion of the pesticide application. Early-entry workers must be equipped with personal protective equipment as required by the pesticide label.

Personal Protective Equipment. Employers must provide pesticide handlers with whatever protective gear is required by the pesticide label. They also must ensure that the equipment fits properly and is used correctly, and that it is clean, intact, and in good operating condition.

Decontamination Site. Water for routine washing and emergency eye flushing, soap, single-use towels, and a change of clothing will have to be provided at a clean site.

Emergency Assistance. If a worker or handler is poisoned or injured from a work-related pesticide exposure, the employer is responsible for making prompt transportation available to an emergency medical facility. The employer also will need to provide product-specific information from the label (product name, EPA registration number, active ingredients, antidote, first aid), and will need to know the circumstances relevant to the application and exposure.

To use this chart:
Find the names of the two materials in question. Locate the intersection of the column and row for these materials. The number in the cell at the intersection indicates whether the materials are compatible (1), not compatible (2), or of questionable compatibility (3). For example, to find whether Bayleton and Bravo can be mixed, go down the column for Bayleton (column 2) until you come to the row for Bravo. There is a "1" in this cell, so the materials are compatible.

FUNGICIDE/INSECTICIDE COMPATIBILITY CHART

1. Materials compatible
2. Not compatible
3. Questionable, compatibility not clear, or generally not mixed together

Ambush																		
1	Bayleton																	
1	1	Benlate, Topsin M																
3	1	1	Bravo															
1	3	2	1	Copper (fixed)														
1	1	1	1	1	Dimethoate													
1	1	1	3	1	1	Diazinon												
3	1	1	1	3	1	3	Dyrene											
1	1	1	3	1	1	3	1	Guthion										
3	1	1	1	1	1	1	2	1	Lannate									
1	1	1	1	3	1	1	3	1	1	Lorsban								
1	1	1	1	1	1	1	1	1	1	1	Mancozeb, Maneb							
1	1	1	1	3	1	1	3	1	1	1	1	Pounce						
1	1	1	1	3	1	1	3	1	1	1	1	1	Penncap M					
3	3	1	1	3	3	1	3	1	3	3	1	3	3	Ridomil				
1	1	1	1	3	1	1	3	1	1	3	1	1	1	3	Rovral			
1	1	1	1	2	1	1	1	1	1	1	1	1	1	3	1	Sevin		
1	1	1	3	1*	1	1	1	1	1	1	1	1	1	3	1	1	Thiodan	
3	1	1	1	3	1	1	3	1	1	1	1	3	1	1	1	1	1	Vydate *

* WP formulation of Thiodan only

Insect Management Strategies

Effective management of insects and mites involves at least six steps:

1. Proper identification of key pest insects and mites, and beneficial organisms.
2. Selection and use of preventive pest management practices.
3. Monitoring the current status of insect and mite populations.
4. Determining the potential for economic loss from the pest.
5. Proper selection of a pest control option.
6. Evaluation of the effectiveness of control options previously used.

Proper Identification

Proper identification of pests is the foundation on which a good insect management program is built. If the pest is not properly identified, the chances of selecting the correct control strategies are greatly diminished. Many insects and mites can be correctly identified simply because they are encountered so often. However, it never hurts to back up your knowledge base with some reference materials. A number of extension bulletins are available from your county extension agent that will help growers properly identify insect pests. There are also a number of good books available with color photographs of many of the common insect pests. Most entomologists don't like to admit it, but we often identify unfamiliar insects by comparing them to pictures in a book.

As will be discussed in the next section, beneficial organisms can be important components of an insect management program. Being able to distinguish the good guys from the bad guys may help you to avoid unnecessary and possibly disruptive pesticide sprays. Some common beneficial organisms that all growers should be able to identify include lady beetle larvae and adults, lacewing larvae and adults, and syrphid fly larvae.

In addition to proper identification, it is helpful to know as much as possible about the biology of the insect. All growers should know the difference between insects with incomplete metamorphosis and those with complete metamorphosis. Insects with incomplete metamorphosis have juvenile stages, called nymphs, that resemble the adult stage except that they are smaller and don't have wings. The feeding behavior is usually the same for nymphs and adults. An example of an insect with incomplete metamorphosis is the squash bug.

Insects with complete metamorphosis have a larval stage that is completely different in appearance from the adult. They also have an intermediate stage, known as a pupa, between the larval and adult stages. Larvae never have wings and are not capable of reproducing. Larvae go through a series of molts (shedding their skin) in order to grow. Larvae and adults frequently, although not always, feed differently. Adult insects never grow, so little beetles don't grow up to be big beetles. Caterpillars are examples of larvae, and the adult stage of a caterpillar is a moth or butterfly. For important insect and mite pests, it is helpful to know the overwintering stage, the length of the life cycle, and the number of generations per year that can be expected. Again, most of this information can be found in extension bulletins.

Preventative Insect Management Practices

There are a number of practices that can be employed to reduce insect numbers before you actually see the insects in the field. Often these decisions must be made based on past experience with the insect, rather than current knowledge of the severity of the infestation. Many of these practices are good management practices for weeds and diseases as well, so they can easily be incorporated into an overall insect management program.

Resistant Varieties: There are not many vegetable varieties that have been bred for resistance to insects. However, there are some varieties of cabbage that are resistant to onion thrips. Selection of sweet corn varieties that have husks that completely cover the ear tip and fit tightly around the ear can reduce the amount of corn earworm damage. Short season varieties of potatoes should be grown when possible to give Colorado potato beetles less time to feed and reproduce. This is not resistance, but it is a method that growers can use to reduce insect damage by varietal selection.

Crop Rotation: Rotating crops can reduce the severity of a number of pest problems. Corn rootworms are not a problem in corn that is planted on land that did not have corn growing there last year. Rotating potato fields can greatly increase the amount of time it takes Colorado potato beetles to colonize a field, thereby reducing the time the beetles have to increase to damaging levels. Don't plant crops that are susceptible to wireworm or white grub damage in fields that were previously in sod or heavily infested with grassy weeds. In addition, it is a good idea not to plant cabbage or onions next to small grain fields, because onion thrips build up to very high

levels in small grains and may move into cabbage or onions when the small grains dry down or are harvested.

Crop Refuse Destruction: Destroying the plant residue after harvest can reduce the damage experienced the next year from a number of insects. Destroying squash and pumpkin vines after completion of harvest can greatly reduce the overwintering population of squash bugs and squash vine borers. Early vine killing in potatoes will reduce the potato beetle populations for the following year.

Tillage: Fields that receive reduced amounts of tillage or have some sort of grass windbreaks are often more susceptible to damage from such insects as cutworms and armyworms. These cultural practices may have other advantages that outweigh the potential insect problems, but growers should be aware of the potential for increased insect activity.

Time of Planting: Because insects tend to become active at specific times each year, varying the time of planting can sometimes help prevent serious insect problems. Corn earworms and fall armyworms are usually a much more serious problem on late-planted sweet corn. If the option is available, planting sweet corn so that it has no green silks before large numbers of earworm moths are flying can reduce earworm problems. Root maggots are usually more serious during cool, wet weather. Waiting until soil temperatures are adequate for rapid plant growth will help reduce maggot problems.

Biological Control: One aspect of biological control that can effectively reduce pest populations and damage is conservation of natural enemies. This can be accomplished in several ways, but the most important is by reducing the number of insecticide applications. Each time a spray is applied, more predators and parasites are killed. When deciding to use an insecticide, you should consider the impact that application will have on beneficial insects. *Bacillus thuringiensis* products do not harm beneficial insects.

Monitoring

Vegetable growers must make decisions concerning management of insect and mite pests on an almost daily basis during the growing season. To make the best management decision, it is often useful to have information regarding the current status of a pest's population. This can be accomplished through some sort of sampling or monitoring program. There are several methods that can be used to monitor insect populations.

Pheromone traps can be used to determine when moths are flying. This information can be used in several ways. First, catching moths in the trap can alert the grower to begin looking for the pest in the field. This can save time because the grower won't be looking for the pest before it is present. Second, pheromone trap catches can be used to time insecticide applications. Third, for some pests such as corn earworms, the need to spray can be determined from the number of moths caught in the trap. Pheromones are available for many of the caterpillar pests of vegetables.

The most common method for monitoring insects is by scouting the field. Scouting can be formal, such as counting insects on a given number of plants throughout the field, or it can be informal, with the grower walking through the field and looking for insects on the plants. Formal scouting may be the more accurate, but the most important thing is for growers to regularly walk their fields looking for insects or insect damage. Some pests, such as mites, may require the use of a hand lens to see. Others may require the use of equipment such as a sweep net or a beat cloth. Most can be monitored just by close inspection of the plants. Regular (weekly) monitoring of fields will allow growers to make informed management decisions.

Determining the Potential for Economic Loss

Unfortunately, we do not have economic thresholds for many vegetable insect pests. Whenever possible, we have listed the best thresholds available along with control options in the crop-specific sections of this manual. Although some of these estimates have not been verified by research in each state, they have been derived from scientific research or extensive observations. Growers may wish to adjust these thresholds based on past experience. Extension bulletins are also useful sources of information regarding potential losses from insects. Growers should remember that some crops, such as snap beans and potatoes, can suffer a great deal of defoliation before there is any effect on yield. Sometimes plants with considerable amounts of insect damage will yield as well as plants that have no insect feeding. If the pest is one that feeds on the marketable portion of the plant, then less damage can be tolerated.

Proper Selection of a Pest Control Option

In vegetable crops, the selection of a control option during the growing season usually means doing nothing or selecting a pesticide. Although we always encourage growers to read and follow label directions, the one area where the label is not necessarily the best source of information is

concerning which insects the insecticide will control. The insecticides recommended in this book for control of various pests are listed because they are legal to use **and** because they have been found to be effective by the authors. Consider the cost of the insecticide, application costs, the relative effectiveness, the gain in profits that can be expected from the application, whether it will control other pests, and how it will affect predators, parasites, and pollinators. Growers should refrain from "revenge spraying," that is, spraying after the damage is already done. At that point, spraying is a waste of money and may actually increase pest damage by killing beneficial insects.

Evaluation

Growers should always evaluate the effectiveness of a pest control action. Inspecting the field a couple of days after an insecticide is applied will help the grower to determine the necessity for additional control measures in that field, as well as providing information about the effectiveness of the insecticide for future reference. Growers should pay attention to whether the insecticide killed all stages of the pests or if only small larvae or nymphs were killed. They should also notice the effects on other pests in the field and on the beneficial insects.

Preharvest Intervals (days) and Re-Entry Intervals (hours) for Insecticides/Acaricides Registered for Use on Midwest Vegetables in 2002*

	Actara	Admire	Agri-Mek	Align, Neemix	Ambush	Ammo	Asana	Avaunt	Bacillus thuringiensis	Baythroid	Capture	Confirm	Cryolite/Kryocide	Danitol	Dimethoate	Diazinon	Fulfill	Furadan	Guthion	Lannate	Larvin	Lorsban	Malathion	Metasystox-R	Mustang	Orthene/Address	Penncap-M	Platinum	Proclaim	Pounce	Provado	Sevin	SpinTor	Thiodan	Vydate	Warrior
Asparagus				0					0						180					1		1							1		1					
Beet				0					0							14				X			7								7					
Broccoli		21		0	1	1	3	3	0		7	14	14	7	7	7			15	3	7	21	3	7	1			7	1	7	3	1	7		1
Brussels Sprouts		21		0	1	1			0		7	14	14	7		7			7	3		21	7	10	1	14			7	1	7	3	1	14		1
Cabbage		21		0	1	1	3	3	0		7	14	14	7	7	21			21	1	7	21	7	7	1			7	1	7	3	1	7		1
Cantaloupe	0	21	7	0	0		3		0		3		14	7	3	3	14	X	7	X				14				30		0		3	3	2	1	
Carrot				0			7		0	0						14				1					1						7		7	14	
Cauliflower		21		0	1	1	3	3	0		7	14	14	7	7	7			15	3	7	21	7	7	1	14			7	1	7	3	1	14		1
Celery			7	0	1				0			14							14	7	14		7		1	21			7	1		14	1	X		
Chinese Cabbage		21		0	1	1	3		0		7	14		7		10			21	10			7	7	1				7	1	7	14	1			1
Collard		21		0	1	1	7		0			14	14		14	10				10		21	7						1	7	14	1	21			
Cucumber	0	21	7	0	0		3		0		3		14	7		7	14	X	4	X			1	3	1			30		0		3	1	2	1	
Eggplant	0	21		0	3		7		0		7	14	14				14		21	5			3	7	7			30		3	0	3	1	1	X	
Endive		21		0	1				0			14			14	14				10	14		7		1				1	7	14	1				
Green Onion				0		7			0							14			14	7			3		1		15								
Head Lettuce		21	7	0	1	5		3	0		7	14	14		7	14				X	14		7	21		21			7	1	7	14	1	14		1
Kale				0		1			0			14			14	10				10		21	7		1					7	14	1	21			
Kidney Bean				0			3		0						0					14			1			14	15			7	21	28	3		
Leaf Lettuce		21		0	1			3	0			14	14		14	14				X	14		14						1	7	14	1	14		1
Lima Bean				0			3		0		3				0	7				X			1	21	1	0				7	3	3	3		
Mint				0					0											14		90	7	14	7	14									
Mustard		21		0		1	7		0			14			14	10				10			7	1	1					7	14	1	21			
Onion Bulb				0	1	7			0							14			28	7		X	3	7			15			1					14
Parsley		21		0	1				0			14								10	14		21	1						1	7	14	1			
Parsnip				0					0							14															7				
Peas				0			3		0		3				0	7				1			3								14	X	5		
Pepper	0	21	7	0	3		7	3	0	7	7	14	14		0	5	14			3			3	3		7		30		3	0	3	1	X	7	
Potato	14	21	14	0	14		7		0	0			0		0	35	14	14	7	6			0				5	X		14	7	7	7	1	7	
Pumpkin	0	21	7	0	0		3		0		3			7			14	X						14				30		0		3	3	2	1	
Radish				0			7		0	0						14						X	7								7				
Rhubarb				0	1				0			14									14			1	1					1			1			
Snap Bean				0			3		0		3				0	7				X			1	1		14					7	14	3	3		
Spinach		21		0	1				0			14			14	14				7	14		7		1				1	7	14	1	21			
Summer Squash	0	21	7	0	0		3		0		3		14	7		7	14	X		X			1	3				30		0		3	3	2	1	
Sweet Corn				0	1		1	3	0	0	1					7		7		0	0	35	5	X	3		4			1		2	1	1		1
Sweet Potato	14	125		0					0								14					125	3					X				7	7	1	X	
Tomato	0	21	7	0	3		1	3	0	0			14	3	7	1	14		X	1			1					30		0	0	3	1	2	3	5
Turnip				0	1				0						14	14				10										1			1			
Watermelon	0	21	7	0	0		3		0		3		14	7	3	3	14	X	7	X				7				30		0		3	3	2	1	
Winter Squash	0	21	7	0	0		3		0		3		14	7		3	14	X					1	14				30		0		3	3	2	1	
Re-Entry Intervals (hours)	12	12	12	4	12	12	12	12	4	12	a	4	12	24	48	24	12	48	a	a	48	a	12	48	12	24	X	12	48	12	12	12	4	24	48	24

a: Re-entry intervals are variable. Check Agricultural Use Requirements on label.
d: Don't enter until dust settles.
X: Check label for details.

*Check label directions before applying any of these pesticides.

Common Names of Registered Insecticides and Acaricides

Common Name	Trade Name	Producer	Formulation
abamectin	Agri-Mek	Syngenta	0.15EC
acephate	Orthene, Address	Valent, Dow Agrosciences	75S, 90S
azadirachtin	Align, Neemix	Thermo Trilogy	
azinphosmethyl	Guthion	Bayer	2L, 3F, 50WP
Bacillus thuringiensis var. *aizawai*	Agree, Xentari, Ketch	Thermo Trilogy, Valent, Dow Agrosciences	38% 10.3%
B. thuringiensis var. *kurstaki*	Dipel, MVP, Javelin, Biobit, Cutlass, Lepinox	Valent, Mycogen, FMC Thermo Trilogy, DuPont,	ES, 2X WP, 4L ES, 10G A, WG, F, WP, P, WPG
B. thuringiensis var. *tenebrionis*	M-Trak, Novodor, Foil	Mycogen, Novo Nordisk, Ecogen	10%, 3%
bifenthrin	Capture	FMC	2EC
carbaryl	Sevin	Bayer	50WP, 80S, 5B, XLR Plus
	Adios	BASF	
carbofuran	Furadan	FMC	4F
chlorethoxyfos	Fortress	DuPont	5G, 2.5G
chlorpyrifos	Lorsban	Dow Agrosciences, Gowan	4E, 15G, 50W
cyfluthrin	Baythroid, Aztec	Bayer	2EC, 2.1G
cyhalothrin	Warrior	Syngenta	1CS
cypermethrin	Ammo	FMC	2.5EC
cyromazine	Trigard	Syngenta	75WP
diazinon	Diazinon	Micro Flo, Gowan	50WP, AG500, 4EC, 14G
dimethoate	Dimethoate	Gowan	E267
disulfoton	Di-Syston	Bayer	8EC, 15G
emamectin	Procliam	Syngenta	5WB
endosulfan	Thiodan, Endosulfan, Phaser	FMC, Gowan, AgrEvo	50WP, 3EC
esfenvalerate	Asana XL	DuPont	0.66 EC
ethoprop	Mocap	Bayer	10G, 20G, 6EC
fenpropathrin	Danitol	Valent	2.4EC
imidacloprid	Admire, Provado	Bayer	2F, 1.6F
indoxacarb	Avaunt	DuPont	30WDG
malathion	Malathion	Many	Many
methamidophos	Monitor	Valent, Bayer	AC
methomyl	Lannate	DuPont	90WSP, 2.4WSL
methoxychlor	Methoxychlor	Wibur Ellis	2S
methyl parathion	Penncap-M	Cerexagri	2F (encapsulated)
naled	Dibrom	Valent	8EC
oxamyl	Vydate	DuPont	2WSL
oxydemeton-methyl	Metasystox-R	Gowan	2SC
permethrin	Ambush, Pounce	Syngenta, FMC	2EC, 25WP, 3.2EC,1.5G
phorate	Thimet	Micro Flo	20G
phosmet	Imidan	Gowan	70WP
pymetrozine	Fulfill	Syngenta	50WG
sodium alumino fluoride	Cryolite, Kryocide	Gowan, Cerexagri	96%
spinosad	SpinTor	Dow Agrosciences	25C
tebufenozide	Confirm	Dow Agrosciences	2F
terbufos	Counter	BASF	15G, 20G
thiamethoxam	Actara, Platinum	Syngenta	25WDG, 2S
thiodicarb	Larvin	Bayer	3.2
tralomethrin	Scout X-Tra	Bayer	0.9EC
zeta-cypermethrin	Fury, Mustang	FMC	1.5EC, 1.5EW

A = aqueous, B = bait, D = dust, E or EC = emulsifiable concentrate, ES = emulsifiable suspension, F = Flowable, G = granules, HPC = high potency concentrate, L = Liquid, S or SP = sprayable powder, W or WP = wettable powder, WSL = water soluble liquid, WSP = water soluble powder, WG = wettable granule.

Weed management requires a multifaceted approach, built upon an understanding of weeds and the crop. Weed management may involve non-chemical methods, chemical methods (herbicides), or a combination of the two. Their aim should be to manage the weed population so it is below a level that will cause a reduction in your economic return (economic threshold). The decision on which methods to use depends on environmental concerns, marketing opportunities, desired management intensity, labor availability, weed pressure, and the crop. In some instances, the cost of controlling weeds may be more than the economic return obtained from any yield increase. This situation occurs when a few weeds are present or the weeds germinate late in the season. In those instances, the best strategy may be to do nothing. In other situations, weed populations and other considerations may require combining herbicides with nonchemical approaches.

The first step in weed management is to identify the weeds and understand their life cycles. Consult identification guides, such as *Weeds of the North Central States* (Bulletin 772, College of Agriculture, University of Illinois at Urbana-Champaign), for assistance. Weeds can be categorized by life cycles, and management strategies developed accordingly.

Annual weeds complete their life cycles in one year and reproduce solely by seeds. Annuals can be divided into summer or winter annuals, depending on when they grow. Primary tillage operations often control winter annuals before a crop is planted in the spring. The most common vegetable crop weeds (e.g., barnyard grass, giant foxtail, common purslane, redroot pigweed, and common lambsquarters) are summer annuals.

Perennial weeds live for more than two years and can reproduce by seed or vegetative structures (stolons, rhizomes, corms, bulbs, tubers, or roots). Because perennial weeds are difficult to manage in vegetable crops, it is usually better not to use a field with severe perennial weed problems.

Many non-chemical weed management methods are common sense farming practices. These practices are of increasing importance due to consumer concerns about pesticide residues, potential environmental contamination from pesticides, and unavailability of many older herbicides.

Cultural Practices

Farm practices should aim to establish a vigorous crop that competes effectively with weeds. This starts with *land selection*. A general rule is not to plant vegetables on land with a history of heavy weed infestation, especially perennial weeds. *Crop selection* can reduce the effects of weed competition. One criterion in selecting a crop should be the weed problems of the field. Plant the most competitive crops in the most weed-infested fields and the least competitive crops in the cleanest ones. Consider planting heavily infested fields as long-term set-aside acres or in non-row crops such as alfalfa. Permanent cover should help prevent buildup of annual weeds.

Table 1. Botanically Related Vegetables

Corn	Cucurbits	Crucifers	Legumes
Sweet corn	Cucumber	Rutabaga	Soybean
Dent corn	Winter squash	Kale	Pea
Amaryllidaceae	Summer squash	Broccoli	Snap bean
Onion	Pumpkin	Cauliflower	Lima bean
Garlic	Muskmelon	Cabbage	Dry bean
Chenopodiaceae	Watermelon	Brussels sprout	
Beet	**Solanaceae**	Radish	
Chard	Potato	Horseradish	
Spinach	Tomato		
	Pepper		
	Eggplant		

Crop rotation is another practice that can reduce weed problems. The characteristics of the crop, the methods used to grow it, and the herbicides used inadvertently allow certain weeds to escape control. Rotation also affects the weed management tools at your disposal. Rotating between crops will improve crop growth and competitiveness. Related vegetables should not be grown in the same location in successive years (Table 1).

Wild proso millet is an example of a problem weed where rotation is important for management. Rotation from sweet corn to small grains, early-planted peas, or alfalfa almost completely eliminates wild proso millet because these crops are established before the soil is warm enough for wild proso millet seed germination. A rotation from sweet corn to broadleaf crops would allow use of postemergence grass herbicides to manage wild proso millet.

Once a crop is selected, use adaptive, vigorous varieties resistant to diseases. Disease-infected plants cannot effectively compete with weeds. Varieties suited for cultivation in Illinois, Indiana, Iowa, and Missouri are listed in each crop section of this production guide.

Narrower row spacings and proper plant densities assure crop closure. A closed canopy shades out later emerging weeds and prevents germination of weed seeds requiring light. Weeds seldom are a problem once canopy closure occurs. Proper row spacing and plant density also allow row cultivation.

Table 2. Classification of Vegetable Crops According to Their Adaptive Field Temperatures

Cool-season		Warm-season	
Hardy*	Semi-Hardy	Tender	Very Tender
Asparagus	Carrot	Snap bean	Cucumber
Broccoli	Cauliflower	Sweet corn	Eggplant
Cabbage	Chinese cabbage	Tomato	Lima bean
Horseradish	Lettuce		Muskmelon
Onion	Potato		Okra
Pea			Pumpkin
Spinach			Squash
			Watermelon

* Hardy crops are most tolerant of cool temperatures and frost, while very tender crops are most susceptible to frost and cool temperatures.

Another cultural method to improve crop competitiveness is to use the correct planting time. Crops can be divided into warm- or cool-season plants, depending on the optimum temperature for their growth. Planting date affects the time to emergence and early seedling vigor of the crop, which are important in determining crop competitiveness. Cool-season crops germinate at cooler soil temperatures and thus compete better against early emerging weeds than warm-season crops. Table 2 lists crops according to their adaptation to field temperatures. Time plantings so that temperatures are favorable for crop growth. *Adequate fertilization and appropriate insect and disease management* are important in assuring a competitive crop. Adequate fertility assures rapid, uniform germination and good crop growth, which enhance the crop's competitive ability. Disease management information and insect management information are contained in this guide. While poor insect and disease control reduce a crop's competitiveness, inadequate weed control can also cause insect and disease problems.

Mulching can be useful in managing weeds. Mulches can be classified as either natural (straw, leaves, paper, and compost) or synthetic (plastics). Because natural mulches are difficult to apply over large areas, they are best for small, specialized areas. Natural mulches should be e spread evenly at least 1 to 1.5 inches thick over the soil to prevent light penetration. Natural mulch materials must be free of weed seeds and other pest organisms and be heavy enough so they will not be easily displaced by wind or water. A major advantage of natural mulches is that they add organic matter to the soil and do not need to be disposed of at the end of the season.

Synthetic mulches are easy to apply, control weeds within the row, conserve moisture, and increase soil temperature. Black or clear plastic mulches are the most common and are effective in improving early-season growth of warm-season crops such as tomato, muskmelon, watermelon, or pepper. Fast early-season growth of these crops improves their competitive ability against weeds. Plastic mulches used in combination with trickle irrigation can also improve water use efficiency.

A disadvantage of plastic mulch is disposal at the end of the season. Many landfills do not accept plastic mulches. Photodegradable plastic mulches have been developed, but their season-long persistence has been a problem, and they degrade into small pieces of plastic that contaminate the environment. Biodegradable plastic mulches are not yet widely available.

Mechanical Practices

Mechanical weed management relies on primary and secondary tillage implements such as the rotary hoe and the row cultivator. Mechanical weed management starts with seedbed preparation. Few no-till systems have been developed for vegetable crops. No-till suggestions are included in the section on reduced tillage systems.

Moldboard plowing is usually the first step in mechanically managing weeds. Moldboard plowing is particularly useful in controlling emerged annual weeds. *Rotary hoeing* is often an important second step in mechanically managing weeds in large-seeded vegetable crops (sweet corn, snap bean, lima bean, and pea). Rotary hoeing should be done after the weeds germinate but before they emerge. Rotary hoeing does not control large-seeded weeds such as velvetleaf and shattercane.

Once the crop has emerged or transplants are established, a *row cultivator* can be used to manage emerged weeds. Adjust the cultivator sweeps or teeth to dislodge or cover as many weed seedlings as possible. Seedling weeds can be killed by cultivating 1 to 2 inches deep. Best weed control is obtained with a row cultivator in relatively dry soils by throwing soil into the crop row to cover small weed seedlings. Avoid crop injury from poor cultivation, which will reduce crop yields.

In some vegetable crops, such as asparagus, *mowing* can be an effective weed management tool. Mowing can prevent the production of weed seeds and kill upright weeds, reducing competition. Mowing must be carefully timed to eliminate perennial, biennial or annual weeds that would compete strongly in vegetables because of their upright growth habit. Timely, repeated mowing also helps deplete the food reserves of perennial weeds (root systems).

Mechanical control has many limitations that must be considered when designing weed management systems. Because mechanical management relies on relatively dry soil, a rainy period may prevent the use of mechanical weed management options and lead to severe weed competition. Relying entirely on mechanical practices to manage weeds is labor intensive, and many growers will use herbicides combined with nonchemical approaches to control especially difficult weeds. Some of these difficult-to-control weeds include wild proso millet in sweet corn, Canada thistle, hemp dogbane, field bindweed, quackgrass, and johnsongrass. Newly introduced problem weeds often show up in scattered patches along headlands and field borders. These are best controlled or eradicated with herbicides before large areas are infested.

Biological Practices

Currently, no management system tools exist in the Midwest for using insects or diseases to control weeds common in vegetable crops. Most biological weed management systems to date have been developed to control problem weeds in rangeland areas in the West. One biological system that has potential in the Midwest is the use of cover crops to suppress the development of weeds. These systems are still experimental, but have promise for reducing herbicide use once they are fully developed.

The most promising cover crop system is the use of winter rye. Winter rye is planted in late summer or early fall and overwintered as a cover crop. In the spring, the rye is killed with either Roundup or Poast one week prior to planting the crop. The rye is left as a mulch on the soil surface, and the crop is no-till planted. The system, although experimental, does appear to provide early season control of many annual weeds.

Problems have been encountered that are still being investigated. These problems include the duration of weed control obtained, the spectrum of weeds controlled, and the requirement of herbicides to initially kill the cover crop and possibly for managing weeds that escape control by the rye. Because the system is experimental, it should be evaluated in small areas before anyone extensively adopts its use. Table 3 summarizes some of the nonchemical weed management practices. (See page 28.) The most effective weed management system is an integrated approach that combines many different practices. This approach must be adaptive, aiming to prevent weed problems or cope with any that occur.

Chemical Weed Management Strategies

Several herbicides are often labeled for a particular crop. Scouting your area to determine which weeds are present will allow you to select the herbicide that will give you the best control.

All the herbicides labeled for a crop are not necessarily listed in this guide. If you are unfamiliar with a herbicide, conduct a small test under your environmental conditions and cultural practices before using the herbicide extensively.

Herbicide Labels

Always Read and Understand the Herbicide Label Before Use. Reading the herbicide label is a very profitable use of your time. Information on the label will direct you to the correct uses, application methods, rates, and potential environmental hazards. Follow label directions for the best possible control with minimal crop injury and environmental contamination. The label contains restrictions on use and discusses environmental and soil conditions that affect crop injury, influence the effectiveness of weed control, and can cause nontarget site effects.

Do Not Use Any Herbicide Unless the Label States That It Is Cleared for Your Particular Use and Crop. Using a nonregistered pesticide can cause harmful residues in the vegetable crop, which can result in crop seizure and consumer injury. The label also states whether the herbicide is a restricted-use or general-use pesticide. Restricted-use pesticide labels contain a statement that the products are restricted and that only licensed applicators can buy them and supervise their application. The information in this production guide is current as of the date of publication. Watch for notices of changes in the U.S. Environmental Protection Agency (EPA) registration of herbicides in the *Illinois Fruit and Vegetable News*, the *Pest Management and Crop Development Bulletin*, the *Iowa Newsletter for Commercial Vegetable and Fruit Growers*, or the Indiana *Vegetable Crops Hotline*.

Reduced Tillage Systems

Reduced tillage systems are a method to combat soil erosion. **Glyphosate** or **Gramoxone Extra** can be applied outside the normal growing season to control emerged weeds in reduced tillage systems. Weeds should be growing actively, and the application must be made before the crop

has emerged. If you are applying glyphosate to control perennial weeds, it is recommended that it be applied before the soil is disturbed. After it is applied, glyphosate must be allowed to translocate throughout the perennial weed for several days, or incomplete control may result. Follow glyphosate label directions carefully for the rates and timing of application. If perennial weeds are not a major problem, you can eliminate early flushes of weeds by applying glyphosate or Gramoxone Extra to all weeds that emerge. Plant the crop with minimal working of the soil. Never apply glyphosate or Gramoxone Extra to an emerged crop because severe crop injury or death will occur.

Glyphosate and Gramoxone Extra will control most annual broadleaf and grass weeds. Neither herbicide has any soil residual activity, so other weed control measures will be necessary during the growing season. Gramoxone Extra will also suppress perennials by killing their shoots, but it does not control regrowth of perennial weeds from rhizomes or other underground storage organs. Glyphosate is better for controlling perennials because it will kill shoots and translocate to destroy underground parts. Glyphosate will only suppress some particularly hard-to-control perennials such as bindweed, hemp dogbane, and milkweed. To obtain control of these perennials, applications of high rates, repeat applications of glyphosate (within label guidelines), or mechanical removal may be necessary.

Herbicide Rates and Guidelines for Use in Vegetable Crops

All herbicide rates given in this guide are in amount of product per broadcast acre. Adjust amounts accordingly for banded applications. Make pre-emergence applications before weeds emerge or after removing any weeds present. Make postemergence applications after weeds have emerged. Make stale seedbed treatments only if weeds have emerged, but no crop plants are present. The herbicide recommendations given in this guide are not intended to replace careful reading of a current herbicide label. Re-registration of older herbicides has affected the availability of many products. Some of the older herbicides not re-registered are not listed in this bulletin, but may be available, and old stocks can still be used.

Environmental and Health Hazards of Herbicides

Non-targeted effects can occur from the use of herbicides. With the increased attention directed toward non-targeted effects of pesticides, it is very important that you educate yourself about these effects and consider them when designing weed management systems. The following section contains discussions of some of the potential environmental and health hazards of herbicides.

Environmental Hazards

Adverse environmental effects from herbicides can have long-term consequences that are difficult to correct and must be avoided. Some environmental hazards, such as herbicide drift and carryover, will affect mainly your operation, while other hazards, such as water contamination, affect all residents. The following sections discuss some of the potential hazards and methods to avoid them.

Herbicide carryover. Herbicide carryover from persistent herbicides has been a particular problem to growers of vegetable crops. Persistence is dependent on herbicide characteristics (method of degradation, water solubility, and rate of application) and site characteristics (soil type, rainfall, and temperature). Avoid carryover because correction of carryover problems once they occur is virtually impossible. The most important method to avoid herbicide carryover is to follow label rotation restrictions. Table 4 summarizes some of the label restrictions. (See page 29.) Always refer to the label for specific information. If differences between the table and herbicide label occur, always follow label informations.

Herbicide drift. Another frequent hazard to vegetable growers is crop injury from herbicide drift. Certain herbicides, if not used correctly, can cause injury to non-target plants. Herbicides such as clomazone (Command), dicamba, and 2,4-D can drift up to a mile and cause serious damage to grapes, tomatoes, peppers, other vegetables, fruit trees, and ornamental plants. Before spraying clomazone, dicamba, or 2,4-D, survey the area for desirable plants.

Spray only on calm days, and use drift inhibitors when appropriate. Minimize drift by applying herbicides with nozzles that produce large droplets. Use an amine formulation of 2,4-D to reduce vapor drift. Spray clomazone, dicamba, and 2,4-D when the temperature is expected to be lower than 80 to 85°F for several days after treatment. Avoid applying clomazone to wet soils. Incorporate clomazone soon after application.

Spray tank residuals. Dicamba or 2,4-D residues in spray tanks can also injure susceptible vegetable crops. Carefully follow label directions for cleaning spray equipment after using dicamba or 2,4-D. If possible, do not use the same spray equipment to apply 2,4-D or dicamba that you use to apply other pesticides.

Herbicide resistance. There are now more than 50 documented reports worldwide of weeds developing resis-

tance to herbicides. Herbicide resistance tends to occur when a persistent herbicide is used year after year in the same field. Thus, continued use of the same herbicide on a perennial crop, such as asparagus, should be avoided. Many of the resistant problems have occurred with triazine herbicides, such as simazine and atrazine. The labels of those herbicides contain information about avoiding resistance problems.

Approaches to prevent herbicide resistance combine herbicides, mechanical (cultivation), and cultural (crop rotation) weed management practices. Rotate between or use tank mixes of herbicides with different mechanisms for killing the plant. For example, in asparagus rotate between Sencor and Treflan. Use tillage to control weeds that escape from herbicide applications. Especially important in minimizing any weed resistance that does occur is to scout your fields, paying special attention to any patches of a weed normally controlled by the herbicide.

Water quality. Residues of some herbicides such as atrazine, metolachlor, alachlor, cyanazine, and metribuzin have been found in surface and/or groundwater. The levels detected have normally been low, but contamination of water resources is a growing concern. For example, groundwater contamination from pesticides and nitrates is a particular concern in areas of the Midwest with sandy soils and shallow groundwater.

Factors determining the potential for groundwater and surface water contamination include herbicide solubility in water, rate of degradation, volatility, and tendency for the herbicide to attach to soil particles or organic matter. Herbicides that have high water solubility and long persistence are a particular concern.

Site characteristics (soil type, soil depth, water table depth, slope, and weather) also can lead to contamination of water resources from herbicides. You should be aware of the potential problem of herbicide contamination and take all possible steps to avoid contamination of surface and subsurface water resources.

Table 3. Summary of Nonchemical Weed Management Practices

PRACTICE	COMMENTS
Cultural	
• Land selection	Avoid fields with a history of weed problems.
• Crop selection	Grow the most competitive crops in fields with history of weed problems.
• Crop rotation	Rotate between vegetables and non-row crops such as alfalfa. Rotate between vegetables in different botanical categories.
• Adapted crop varieties	Select crop varieties adapted for your area.
• Proper row spacings and plant densities	Use row spacings and plant densities that assure rapid crop canopy closure.
• Correct planting times	Plant crops when soil temperatures favor rapid germination and emergence. Do not plant warm-season crops too early in the season.
• Appropriate fertility, disease, and insect management	Vigorous, healthy crops are more competitive against weeds.
• Mulch	Natural mulches are difficult to use over large acreages. Synthetic (plastic) mulches are useful to manage weeds within the row in warm-season crops. Consider disposal problems when using plastic mulches.
Mechanical	
• Moldboard plowing	This can eliminate emerged annual weeds.
• Rotary hoeing	This is useful to manage small-seeded weeds in large-seeded crops such as sweet corn, snap bean, lima bean, and pea.
• Row cultivator	Dislodge or cover as many weed seedlings as possible. Avoid damaging crop root systems.
• Mowing	Mow weeds as soon as flowers appear so no viable weed seed is produced.
Biological	
• Cover crops	This is still experimental. Winter rye system is the most promising and most effective against small-seeded broadleaf weeds.
• Insect or disease pests of weeds	No current systems use insects or diseases to manage weeds common to vegetables.

Table 4. Label Restrictions (in Months) on Rotating to Vegetable Crops

Herbicide	Tomato	Pea	Snap Bean	Sweet Corn	Pumpkin	Melon	Cole Crops
Soybean Herbicides							
Canopy	10[2]	12	12	18	18	18-30	18-3
Canopy XL	12[2]	30	30	18	18	18-30	30
Classic	15[2]	FB	FB	FB	FB	FB	FB
Command	NNY	AT	9	9	AT	9	NNY
Commence	NNY	9	9	9	9	9	NNY
Cover (Authority)	30	30	30	18	18	18	30
Detail	18	18	11	18	18	18	18
Domain	NNY	NNY	NNY	NNY	NNY	NNY	NNY
Dual (II) Magnum	6	AT	AT	AT	18	18	18
First Rate	30	9	9	18	30	30	30
Flex Star	18	10	10	18	18	18	18
Gauntlet	NNY	NNY	NNY	18	NNY	NNY	NNY
Lexone or Sencor	4-10	4-10	12	12	12	12	12
Lorox	NNY	NNY	NNY	4	NNY	NNY	NNY
Passport	26	AT	AT	18	18	18	26
Pursuit DG[3]	40+FB	4	4	18	40+FB	40+FB	40+FB
Pursuit Plus	26	4	4	18	18	18	26
Python	26	4	4	10.5-18V	26	26	26
Raptor	9	9	9	9	9	9	18
Reflex	18	10	18	10	18	18	18
Salute	4	8	12	4	12	12	12
Scepter	18	18	11	18	18	18	18
Squadron	18	18	11	18	18	18	18
Synchrony STS	9[2]	15	15	15	15	15	15
Tri-Scept	18	18	11	18	18	18	18
Corn Herbicides							
Aatrex and others	NNY	NNY	NNY	AT	NNY	NNY	NNY
Accent, soil pH < 6.5	10	10	10	10	10	10	10
Accent, soil pH > 6.5	18	18	18	18	18	18	18
Aim	12	12	12	0	12	12	12
Axiom/Axiom AT	NNY	NNY	NNY	NNY	NNY	NNY	NNY
Basis	18	8	8	10	18	18	18
Beacon	18	18	18	8	18	18	18
Bicep, Bicep II	18	18	18	AT	18	18	18
Bladex	NY	NY	NY	AT	NY	NY	NY
Callisto	18	18	18	NY	18	18	18
Epic	NNY	NNY	NNY	NNY	NNY	NNY	6
Exceed	10	10	10	3	18	18	10
Extrazine II	18	18	18	AT	18	18	18
Hornet	26	10.5-18V	10.5-18V	10.5-18V	26	26	26
Harness Xtra	NNY	NNY	NNY	NY	NNY	NNY	NNY
Lariat, Bullet	NNY	NNY	NNY	AT	NNY	NNY	NNY
Leadoff	NNY	NNY	NNY	AT	NNY	NNY	NNY
Lightning	40	9.5	9.5	18	40	40	40
Marksman	18	18	18	AT	18	18	18
Northstar	18	8	18	8	18	18	18
Permit	8[2]	9	9	3	9	18	12-18
Princep	NNY	NNY	NNY	AT	NNY	NNY	NNY
Resolve	26	9.5	26	18	26	26	26
Stinger	18	18	18	10.5	18	18	10.5
Surpass, TopNotch, Ful-Time	NNY	NNY	NNY	NY	NNY	NNY	NNY

[1]The rotation restrictions are in months after application.

[2]Transplanted tomatoes only.

[3]In Indiana, replant restrictions for transplanted tomatoes and peppers, cabbage, melons, and cucumbers is 18 months.

NOTE: AT = anytime herbicide labeled for the crop or no rotation restriction exists, FB = a field bioassay required before planting the crop, NY = the crop can be planted the year after application, NNY = not next year, the crop cannot be planted the following year, V=variable, intervals vary by variety or conditions specified on label, next year.

Relative Effectiveness of Herbicides[1] for Vegetable Crops

Ratings Key

G=Good
F=Fair
P=Poor
N=None/ Not Labeled

		Barnyard Grass	Crabgrass	Fall Panicum	Foxtails	Goosegrass	Yellow Nutsedge	Annual Morningglory	Galinsoga	Jimsonweed	Lambsquarter	Nightshade	Pigweed	Purslane	Ragweed	Smartweed	Velvetleaf
PREPLANT INCORPORATED HERBICIDES	Balan	G	G	G	G	G	P	P	P	P	F	P	G	P	P	P	P
	Devrinol	G	G	G	G	G	N	N	P	N	F	N	G	G	N	P	N
	Dual (II) Magnum	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Eptam	G	G	G	G	G	F	P	P	N	F	F-P	G	G	P	P	F
	Frontier/Outlook	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Prefar	G	G	G	G	G	N	N	N	N	F	N	F	F	N	N	N
	Prowl/ Pendimax	G	G	G	G	G	N	N	N	N	G	P	G	G	P	P	P
	Pursuit Plus	N	N	N	N	N	N	N	N	N	N	G	G	N	N	N	N
	Ro-Neet	G	G	G	G	G	F	N	F	N	F	P	G	F	P	P	P
	Sonalan	G	G	G	G	G	N	N	N	N	F-G	F	F-G	F-G	N	P	N
	Sutan+	G	G	G	G	G	G	P	F	P	P	P	F	P	P	P	F
	Tillam	G	G	G	G	G	P	N	F	N	F	N	F	P	P	P	N
	Trifluralin	G	G	G	G	G	N	F	N	N	G	P	G	G	P	P	P
PREEMERGENT SURFACE APPLIED HERBICIDES	Alanap	P	P	P	P	P	N	F	F	F	G	P	G	F	F	F	F
	Atrazine	G	G	P	F	G	F	F-G	G	G	G	G	G	G	G	G	F
	Bladex	G	G	F	G	G	N	G	G	G	G	G	G	G	G	G	
	Command	G	G	G	G	G	N	F	P	F	G	P	P	G	G	G	G
	Curbit	G	G	G	G	G	N	N	F	N	F	F	G	G	P	P	N
	Dacthal	G	G	G	G	G	N	N	N	P	G	N	F	G	N	N	N
	Dual (II) Magnum	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Frontier/Outlook	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Goal	P	F	F	P	P	N	F	G	F-G	G	G	G	G	G	G	F
	Karmex	G	F	F	G	G	P	G	G	G	G	G	G	G	G	G	G
	Kerb*	F	F	P	F	F	P	P	P	P	F	P	P	G	F	F	P
	Lasso	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Lexone/Sencor	F	F	F	F-G	F	N	N	G	F	G	N	G	G	G	G	G
	Lorox	F	F	F	F	F	N	P	G	F	G	F	G	G	G	G	G
	Matrix	G	P-F	G	G	G	P	P	N	F	F	P	G	F	P-F	F	F
	Prowl/Pendimax	G	G	G	G	G	N	N	N	N	G	P	G	G	P	P	P
	Pursuit	P	P	P	G	P	P	P	G	F	F	G	G	G	P	G	F
	Pyramin	F	F	F	F	F	N	P	P	F	F	G	G	G	G	G	F-G
	Sinbar	G	G	G	F-G	G	P	F-G	G	G	G	G	F-G	G	G	G	G
	Solicam	G	G	G	G	G	F	N	G	N	F	F	F	F	G	F	F
	Surflan	G	G	G	G	G	N	F	N	N	G	P	G	G	P	P	P
POSTEMERGENT HERBICIDES	Accent	G	P	G	G	G	P	G	P	G	P-F	P	G	P	P	G	P
	Aim	N	N	N	N	N	N	G	N	N	G	G	F-G	N	F	F	G
	Assure II	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	Atrazine + oil	G	G	F	F-G	G	G	F-G	G	G	G	G	G	G	G	G	G
	Basagran	N	N	N	N	N	G	F	G	G	F	P	P	F-G	F	G	G
	Bladex	G	F	P	G	G	N	F	G	P	G	G	F	G	G	G	P
	Buctril	N	N	N	N	N	N	G	N	G	G	G	F	P	G	G	G
	Caparol	F	F	F	F	F	N	F	G	G	G	G	G	G	G	F	G
	2,4-D	N	N	N	N	N	N	G	G	F	G	G	G	P	G	P	F
	Evik**	G	G	G	G	G	F	G	G	G	G	F	G	F	G	G	G
	Fusilade	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	Glyphosate	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G
	Goal	P	P	P	P	P	N	F	G	G	F	G	E	G	G	F	F
	Lexone/Sencor	F	F	F	F	F	N	F-G	G	F	G	P	G	G	G	G	G
	Lorox	F	F	F	F	F	N	G	G	F	G	G	G	G	G	G	G
	Matrix/ Shadeout	G	P-F	G	G	G	F	F	N	G	F	P	G	F	P-F	F	F
	Paraquat	G	G	G	G	G	G	G	F-G	G	G	G	G	G	G	G	G
	Permit	N	N	N	N	N	G	N	N	N	P	N	F-G	N	G	F-G	G
	Poast	G	F-G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	Reflex	N	N	N	N	N	N	N	N	N	N	F-G	N	N	F-G	N	N
	Select	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	Spin-aid	N	N	N	N	N	N	F	G	F	G	F	P	G	G	G	F
	Stinger	N	N	N	N	N	N	N	N	G	G	N	G	N	G	F	N

[1] For pre-packaged mixtures, see ratings for individual components.
*Excellent against quackgrass
**Post-directed spray

Preharvest Intervals (days) and Entry Intervals (hours) for Herbicides Registered for use on Midwest Vegetables in 2002*

	Accent	Aim	Alanap	Assure II	Atrazine	Balan	Basagran	Bladex	Buctril	Command 3ME	Curbit	Dacthal	Devrinol	Diuron	Dual (II) Magnum	Eptam	Eradicane	Evik	Frontier, Outlook	Fusilade	Goal, Galigan
Asparagus														X						1	
Beet																					
Broccoli												X									X
Cabbage										45		X									X
Carrot																				45	
Cauliflower												X									X
Collard												X									
Cucumber			X							45	X	X									
Dry Bean				30			30					X			X	X			70		
Eggplant												X									
Endive/Escarole																				28	
Horseradish												X									
Kale												X									
Lettuce						X															
Lima Bean							30								X						
Mint				30			X		70												X
Muskmelon			X							X	X	X									
Mustard												X									
Onion, dry bulb									X			X								45	45
Onion, green bunching									X			X									
Parsley																					
Parsnip																					
Pea				30			30			X					X						
Pepper										X		X	X								
Potato												X			40-60	45					
Pumpkin											X										
Radish																					
Rhubarb																					
Snap Bean				15			30			45		X			X	X					
Spinach																					
Squash										45	X	X									
Sweet Corn	X	X			X		X	X							X		X	X	50		
Sweet Potato										95		X								55	
Tomato												X	X								
Turnip, greens												X									
Turnip, root												X									
Watermelon			X							X	X	X									
Re-Entry Intervals (hours)	4	12	48	12	12	12	12	12	24	12	24	12	12	12	24	12	12	12	12	12	24
X: Check label for details.																					

*Check label directions before applying any of these pesticides.

Preharvest Intervals (days) and Entry Intervals (hours) for Herbicides Registered for use on Midwest Vegetables in 2002*

	Kerb	Lasso, Others	Lorox	Matrix	Paraquat	Permit	Poast	Prefar	Prowl, Pendimax	Pursuit Plus	Pyramin	Reflex	Ro-Neet	Select	Sencor	Sinbar	Solicam	Sonalan	Spin-Aid	Stinger	Sutan+	Tillam	Touchdown	Trifluralin	2,4-D
Asparagus					6		1								14	5	14			2			X	X	X
Beet							60				X		X						60				X		
Broccoli							30	X															X	X	
Cabbage					X		30	X															X	X	
Carrot			14				30							30	60								X	X	
Cauliflower							30	X															X	X	
Collard							30	X															X	X	
Cucumber							14	X						14									X		
Dry Bean							30		X	X		30		30				X					X	X	
Eggplant					X		20	X						20									X	X	
Endive/Escarole	55						15	X															X	X	
Horseradish							60																X		
Kale							30	X															X	X	
Lettuce	55				X		15-30	X															X		
Lima Bean							15		X	X													X	X	
Mint							20									60				45			X	X	
Muskmelon					X		14	X						14									X		
Mustard							30	X															X	X	
Onion, dry bulb					60		30	X	45					45										60	
Onion, green bunching							30																X		
Parsley			30				15	X															X		
Parsnip			X																				X		
Pea							15		X	X													X	X	
Pepper					X		20	X						20									X	X	
Potato			X	60			30		X					30	60								X	X	
Pumpkin					X		14	X						14									X		
Radish														15									X	X	
Rhubarb							30																X		
Snap Bean							15		X														X	X	
Spinach							15																X		
Squash					X		14	X						14									X		
Sweet Corn		X			X	X			X												X		X		X
Sweet Potato														30									X		
Tomato					30		20							20	7							8	X	X	
Turnip, greens																							X		
Turnip, root																							X		
Watermelon					X		20	X						14									X		
Re-Entry Intervals (hours)	24	12	24	4	12-24	12	12	12	24	24	12	24	12	24	12	12	12	24	24	12	12	12	12	12	48
X: Check label for details.																									

*Check label directions before applying any of these pesticides.

Common Names of Registered Herbicides

Common Name	Trade Name	Producer	Formulation
alachlor	Lasso, Partner	Monsanto	4E, 65WDG
ametryn	Evik	Syngenta	76DF
atrazine	Many	Many	many
benefin	Balan	United Agri-Products	60DF
bensulide	Prefar	Gowan	4E
bentazon	Basagran	BASF	4L
bromoxynil	Buctril	Bayer	2E
butylate	Sutan+ 6.7E	Cedar Chemical	6.7E
carfentrazone	Aim	FMC	40WSG
clethodim	Select	Valent	2EC
clomazone	Command	FMC	3ME
clopyralid	Stinger	Dow Agrosciences	3E
cyanazine	Bladex	DuPont	4L, 90DF
cycloate	Ro-Neet	Cedar Chemical	6E
DCPA	Dacthal	AMVAC	75W
dimethenamid	Frontier, Outlook	BASF	6E
diquat	Diquat, Reglone	Syngenta	2E
diuron	Karmex, Direx, Diuron	Griffin, Drexel	80DF, 4L
endothall	Des-i-cate II	Cerexagri	2L
EPTC	Eptam, Eradicane	Syngenta, Cedar Chemical	7E, 10G, 6.7E
ethalfluralin	Curbit, Sonalan	United Agri-Products, Dow Agrosciences	3EC
fluazifop-butyl	Fusilade DX	Syngenta	2E
fomesafen	Reflex	Syngenta	2L
glyphosate	Roundup UltraMax, UltraDry, Custom	Monsanto	4L, 3.7L, 65WSG
	Glyfos, Glyfos X-tra	Cheminova	3L
	Glyphomax Plus	Dow Agrosciences	4L
	Glyphosate	DuPont	3L
	Glyphosate Original	Griffin	3L
	Touchdown	Syngenta	
halosulfuron	Permit	Monsanto	75WSG
imazethapyr	Pursuit	BASF	70DG
imazethapyr+pendimethalin	PursuitPlus	BASF	EC
linuron	Lorox, Linex	Griffin	50DF, 4L
MCPB	Thistrol	Bayer	2EC
metolachlor	Dual (II) Magnum	Syngenta	7.6E
metribuzin	Sencor	Bayer	4F, 75DF
napropamide	Devrinol	United Phosphorous	50DF, 2E
naptalam	Alanap	Uniroyal	2L
nicosulfuron	Accent	DuPont	75DF
norflurazon	Solicam	Syngenta	80DF
oxyfluorfen	Goal, Galigan	Dow Agrosciences Makhteshim-Agan	2E, 1.6E
paraquat	Gramoxone Extra, Boa	Syngenta, Griffin	2,5E
pebulate	Tillam	Cedar Chemical	6E
pelargonic acid	Scythe	Dow Agrosciences	
pendimethalin	Prowl, Pendimax	BASF, Dow Agrosciences	3.3E
phenmedipham	Spin-Aid	Bayer	1.3E
pronamide	Kerb	Dow Agrosciences	50W
pyrazon	Pyramin	BASF	65DF, 4.5SC
quizalofop	Assure II	DuPont	0.88E
rimsulfuron	Matrix, Shadeout	DuPont	25DF
sethoxydim	Poast, Ultima 160	BASF	1.5E, 1.3E
2,4-D Amine	Formula 40, others	Riverdale	Many
terbacil	Sinbar	DuPont	80W
trifluralin	Treflan HFP, Trilin, Trifluralin	Dow Agrosciences, Griffin, Gowan, Drexel, UAP, and others	4E, 10G

Disease Management Strategies

Managing diseases effectively involves making the best possible decisions to reduce the risk of serious disease-related losses. The strategies upon which effective management is based are those of disease prevention and slowing the spread of diseases. That is, within a given season or over several seasons, the objective is to prevent disease outbreaks and the development of severe early-season epidemics. Several options for achieving this objective are discussed below.

Disease Diagnosis

Accurate diagnosis of crop disorders is an essential first step in disease management. Knowledge that certain diseases occur regularly in particular fields can be helpful when planning for future crops. The chances for bad decisions regarding the use of fungicides for protection or remedial treatment are greatly reduced with knowledge of diseases and their symptoms. Even the ability to distinguish between infectious (those which can be spread from plant to plant) and non-infectious (nutrient imbalances, herbicide injury, etc.) disorders is valuable in making disease-control decisions because diagnosis in the field often involves eliminating unlikely possibilities first. Growers who have a reasonably good understanding of the types of infectious and non-infectious disorders that can occur have a better chance of making the correct disease-control decisions.

Healthy Plant Material

One of the fundamental prerequisites for a healthy crop is the use of healthy seed or transplants. A crop started with infected or infested plant material will result in low yields with poor quality and often will cost more to produce because of wasted efforts at chemical control. Also, the diseased crop may thoroughly contaminate a field and could remove it from production for an extended period of time. Diseases are occasionally introduced via contaminated seed from seed companies, but the commercial seed companies remain the most reliable source of plant material. Saving vegetable seeds for next year's crop is not recommended. There has been a recent trend throughout the Midwest towards local greenhouse production of transplants (see Transplant Production, page 4). Although local transplant production offers advantages in environmental control over the crop and an escape from chronic southern soil-borne diseases, there may be offsetting disadvantages in the risk of spread of seed-borne disease and other diseases endemic to northern states.

Disease-Resistant Varieties

The use of disease resistant varieties is among the most reliable and least expensive disease-control options. Although resistant varieties may not be as productive as traditional, susceptible varieties, the lower yields may be offset by the fact that disease-related losses will be reduced or eliminated. There are other advantages to using resistant varieties. If varieties that are resistant to a soilborne disease are used, then a long-term decline in the pathogen population can be expected, especially if implemented in combination with reasonably long crop rotations. If varieties resistant to a foliar disease are planted, then considerable savings from reduced fungicide applications can be expected. Unfortunately, resistant varieties do not exist for all diseases on all vegetable crops, so it is important to take advantage of such options when they are available.

Resistance may be complete, where no disease symptoms occur, or incomplete, where disease symptoms occur, but the severity of the disease is much reduced compared to susceptible varieties. Examples of diseases to which complete resistance is expressed include Fusarium wilt of tomato, Fusarium yellows of cabbage, and powdery mildew of muskmelon. Examples of diseases to which incomplete resistance is expressed include black rot of cabbage, Phytophthora blight of pepper, tomato anthracnose, and smut of sweet corn. It is possible for pathogen populations to overcome the complete type of resistance and result in a major disease outbreak. The chance of this occurring is rare, however, and should not prevent growers from using these varieties. Incomplete resistance is most effective when used in combination with other control methods.

Tillage and Crop Rotation

Many plant pathogens overwinter in association with crop residue and are unable to survive once the crop residue is decomposed. Tillage (especially fall tillage) helps control disease by reducing the amount of inoculum that survives the winter. Rotating fields to different crops each year helps control disease by preventing the build-up of certain plant pathogens in the soil. The longer the rotation, the less likely that a severe early season disease outbreak will occur. It is important to rotate to unrelated crops, (e.g., tomatoes to cucurbits, cucurbits to crucifers, crucifers to sweet corn, etc.). Crop rotation used in combination with effective tillage methods and resistant varieties offers a great opportunity to reduce the dependence on fungicides for disease control.

Some soilborne diseases are unaffected by rotation. Such diseases are caused by pathogens that produce resilient

survival structures that can withstand the effects of time and non-host crops. Examples include Phytophthora blight, Fusarium wilt, and root knot nematode. Others have such a broad host range that they survive indefinitely because so many crop and weed species serve as hosts. Examples include Sclerotinia, Rhizoctonia, and Verticillium diseases. Also, there are some important pathogens that are not affected by tillage or crop rotation because they overwinter in Gulf Coast states. Examples include sweet corn rust and downy mildew of cucurbits. Decisions regarding tillage and crop rotation should be made with consideration that although rotation is a good general practice to improve or maintain good soil tilth, tillage (especially fall tillage) is often not in accord with recommended soil management and conservation practices.

Other Cultural Practices

Other practices, such as altering time of planting, modifying irrigation methods or scheduling, use of raised beds, and altering plant density can also be used to make conditions less favorable for disease. For example, planting seeds only in warm, well-drained soils can reduce levels of seedling diseases caused by *Pythium* and other soilborne fungi.

Chemical Control: Fungicides, Bacteriacides, Nematicides, Fumigants

The decision to apply chemicals for disease control can save a crop from certain economic loss or can result in a waste of financial resources. The difference in the results of such a decision often depends upon the user's understanding of the nature of the disease in question. Knowing which disease is present is of primary importance; once that is understood, the grower only has to select the appropriate product for treatment and read and follow label directions.

Fungicides can be classified as protectants or eradicants. A protectant fungicide is designed to serve as a chemical barrier to infection by plant pathogenic fungi. Protectant fungicides are not absorbed by the plant and do not "burn out" existing infections. Their purpose is only to prevent successful spore germination and infection. Once an infection has occurred, a lesion will develop and produce more spores, despite the presence of a protectant fungicide. Because the fungicide deposit must come into contact with a germinating spore to be effective, incomplete coverage of the plant surface by the fungicide can result in unexpectedly high levels of disease. Therefore, for a protectant fungicide to be effective, it should be applied repeatedly throughout the season and in such a manner as to achieve acceptable coverage of the crop. Protectant fungicides are often referred to as "broad spectrum" fungicides because they traditionally have been effective against diverse groups of plant pathogenic fungi.

Eradicant fungicides are also called "systemic" fungicides because they are absorbed into the plant, where they are able to eradicate existing infections. Advantages of using eradicant fungicides are that coverage of plant surfaces does not need to be as extensive as with protectant fungicides, and that they do not need to be applied as often. Disease scouting programs can often be used if an eradicant fungicide is available. Unfortunately, eradicant fungicides have been developed for only a few pathogens. Also, if these fungicides are not used properly, they can prompt the development of new strains of some pathogens that are resistant to the fungicide. In order to maintain the effectiveness of eradicant fungicides, they usually are applied as a tank mix with a broad spectrum, protectant type of fungicide. The need for fungicide applications can be affected by several factors, including the following: weather conditions (moisture and temperature), levels of host resistance, stage of crop development, and levels of pathogen inoculum. A more complete understanding of how these factors affect the disease process can allow the grower to use fungicides more efficiently and effectively.

Bacteriacides (copper and antibiotic compounds) can play a role in reducing the risk of early-season bacterial disease epidemics. Copper compounds are also mediocre fungicides and are handled similarly to protectant fungicides. They will be effective only if disease incidence is very low prior to the initial application and if protection is maintained during extended periods of disease-favorable weather. Antibiotics serve a similar purpose in certain crops. Normal summers in Midwestern states include periods of warm, rainy weather that are ideal for the increase and spread of bacterial diseases. Because bacterial diseases spread so rapidly, chemical control alone is not sufficient to protect against severe epidemics. Bacteriacides are most effective when used in conjunction with other control methods.

Nematicides and fumigants are designed to reduce populations of nematodes and soilborne fungi before the crop is planted. Like other disease-control chemicals, they are most effective when used in combination with cultural control options such as extended crop rotations and resistant varieties.

Systemic Acquired Resistance

Plant pathologist have known for several years that under specific circumstances, plants exposed to various chemicals, microorganisms or physical stress are better able to withstand plant diseases. This phenomenon is known as Systemic Acquired Resistance. Today, there are two pesticides that induce Systemic Acquired Resistance in vegetable plants: Actigard and Messenger. Neither of these pesticides seem to cause an increase in the plant's ability to fight plant diseases.

There is still much to be learned about Actigard and Messenger in particular and about Systemic Acquired Resistance in general. At this point, we can make several generalizations:

- Both chemicals should be used as part of a general overall program to control plant diseases. Such a program should include the cultural and chemical controls listed in this guide. Do not use either Actigard or Messenger as an act along pesticide.

- It takes some time for both Actigard and Messenger to affect any changes in plants. Therefore, application of both chemicals should begin early, before the plants become diseased.

- These pesticides acta by a different mode of action and therefore have a relatively novel set of instructions. As always read and follow the label carefully.

Actigard - Labeled for tomatoes for bacterial spot and bacterial speck, and for spinach for downy mildew and white rust. Some positive results have been obtained with Actigard, particularly with bacterial spot of tomato. Actigard has been associated with yield loss in some situations. Therefore, follow precautions on the label carefully. For example, avoid applying Actigard to plants that are stressed by drought, heat, etc.

Messenger - Labeled for several different vegetable crops including greenhouse use. Instructions for some crops include mention of specific diseases, while for other crops Messenger is said to "boost overall vigor and to aid in the management of disease". Since Messenger is a relatively new pesticide with a new chemistry, little work has been done by University personnel to test its effectiveness. Therefore, Messenger is not listed under individual crops in the *Midwest Vegetable Production Guide for 2002*.

Summary of Cultural Management Strategies for Disease

This table describes several diseases, listed by crop. The list is not exhaustive, but represents diseases of importance in the midwest. Also listed are the cultural management options available for each disease. The management options are described in more detail in the text. Note that some pathogens have races. The reaction of a particular race of fungus or bacterium will depend on the cultivar or variety grown. Rotation refers to the number of years that the field should be planted to a different crop.

Crop	Disease	Tillage*	Seedborne	Rotation**	Resistance	Other
Cabbage	Alternaria leaf spot	3	Yes	3-4 Years	No	
	Black Rot	3	Yes	2-3 Years	Yes	
	Yellows	2	Yes	Long	Yes	Fusarium fungus survives in soil
Carrot	Bacterial Blight	3	Yes	2-3 Years	No	
	Alt. Leaf Blight	3	Yes	2 Years	Yes	
Cucumber	Angular Leaf Spot	3	Yes	2 Years	Yes	
	Anthracnose	3	Yes	2 Years	Yes	
	Bacterial Wilt	1	No	-------	No	Spread by cucumber beetles
	Scab	3	Yes	3 Years	Yes	Favored by cool (<70° F), wet weather
Muskmelon	Alt. Leaf Blight	3	No	2 Years	No	
	Anthracnose	3	Yes	2 Years	No	
	Bacterial Wilt	1	No	------	No	Spread by cucumber beetles
	Gummy Stem Blight	3	Yes	2 Years	No	Also affects pumpkin, watermelon
	Powdery Mildew	2	No	2 Years	Yes	
	Root Knot	2	No	Long	No	
Pepper	TMV	1	No	2 Years	Yes	Mechanical transmission
	PVY	1	No	2 Years	Yes	Aphid transmission (reflective mulch)
	TEV	1	No	2 Years	Yes	Aphid transmission (reflective mulch)
	Phytophthora	2	Yes	2-3 Years	Yes Races	
	Bacterial Spot	3	Yes	2 Years	Yes Races	
Potato	Early Blight	3	No	3-4 Years	Partial	More disease on early maturing cultivars
	Late Blight	3	Yes	2-3 Years	Partial	Survives on cull piles and volunteers
Pumpkin	Virus Diseases (several)	1	No	-------	No	Aphids spread virus. All cucurbits affected. May also be mechanically spread. Control with planting date & reflective mulch.
	Black Rot	3	Yes	2 Years	No	Same as GSB on muskmelon, watermelon
	Powdery Mildew	2	No	-----	Yes	Some new cultivars with resistance
	Bacterial Fruit Spot	3	Yes	2 Years	No	Affects pumpkins and squash

*1 = tillage has limited effect; 2 = tillage is of moderate importance; 3 = tillage is an important tool.
**Long = rotations are not generally effective unless longer than 5 or 6 years.

Summary of Cultural Management Strategies for Disease (cont.)

Crop	Disease	Tillage*	Seedborne	Rotation**	Resistance	Other
Snap Bean	Rhizoctonia Root Rot	3	No	----	No	Deep plow residue
Sweet Corn	Stewart's wilt	1	Yes	----	Yes	Spreads & survives in flea beetles
Tomato	Early Blight	3	No	3-4 years	Partial	Some resistance to stem canker
	Septoria	3	No	2-3 years	No	
	Fus. Crown Root	2	No	Long	No	(Fus.=Fusarium)
	Bacterial Spot	3	Yes	2-3 years	No	
	Speck	3	Yes	2 Years	Yes	
	Canker	3	Yes	3-4 years	No	
	Verticillium	2	No	Long	Yes	
	TMV	1	No	2 Years	Yes	Can be spread by contact
	Fusarium Wilt	2	Yes	Long	Yes races	
	Root Knot	2	No	Long	Yes	
	Anthacnose	3	Yes	2-3 years	Partial	Stake & Mulch
Vegetables (all)	Damping-off	1	No	----	No	Warm soils; sanitation
Watermelon	Anthracnose	3	Yes	3 Years	No	
	Gummy Stem Blight	3	Yes	3 Years	No	Also affects muskmelon, pumkin & squash
	Root Knot	2	No	Long	No	
	Fusarium Wilt	2	Yes	Long	Partial	
	Bacterial Fruit Blotch	3	Yes	2 Years	No	Volunteer watermelon and cucurbit weeds can spread disease next season
Broadleaf Vegetables	Sclerotinia	2	No	w/grasses 3-4 years	No	Flood 23-45 days

*1 = tillage is an important control; 2 = tillage is of limited help; 3 = tillage has limited effect.
**Long = rotations are not generally effective unless longer than 5 or 6 years.
Data compiled by Dan Egel.

Common Names of Registered Fungicides

Common Name	Trade Name	Producer	Formulation
acibenzolar-S-methyl	Actigard	Syngenta	50WG
azoxystrobin	Quadris	Syngenta	2.08SC
chlorothalonil	Agronil, Bravo 500	Helena, Syngenta	720F500F
	Bravo Ultrex	Syngenta	82.5DG
	Bravo Weather Stik	Syngenta	720F
	Bravo Z	Syngenta	500F
	Equus	Griffin	DF, 720F
	Terranil Cu	Agriliance	24F
	Echo	Sostrom	720F
copper hydroxide*	Kocide 101, 4.5F, DF	Griffin	50WP, 4.5F, 61DF
	Champion	Agtrol	50WP
	Champ	Agtrol	4.5F
copper sulfate basic*	Basicop	Griffin	53WP
	Cuprofix Disperse	Ceraxgri	20DF
	Tribasic Copper Sulfate	Citco	53WP
copper resinate	Citcop 5E	Tennessee Chemical	5EC (5%)
cymoxanil	Curzate DF	DuPont	60DF
DCNA	Botran	Gowan	75WP
dimethomorph plus mancozeb	Acrobat MZ	BASF	69WP
fosetyl-AL	Aliette	Bayer	80WP
iprodione	Rovral	Bayer	50WP
mancozeb	Gavel, Dithane M-45, DF	Rohm & Haas, Dow Agrosciences	75 DF, 80WP, 80DG
	Manzate 200 DF	Griffin	80 DG
	Penncozeb	Cerexagri	80WP
	Penncozeb DF	Cerexagri	75DF
	Manex II	Griffin	4F
maneb	Maneb 80	Cerexagri	80WP, 75DF
	Manex	Griffin	4F
mefenoxam (replaces metalaxyl)	Ridomil Gold Copper	Syngenta	65WP
	Ridomil Gold Bravo	Syngenta	76WP
	Ridomil Gold EC	Syngenta	47EC
	Ridomil Gold MZ	Syngenta	68WP
Myclobutanil	Nova	Dow Agrosciences	40W
PCNB	Terrachlor	Uniroyal Chemical	10DG, 75WP, 40F
propamocarb hydrochloride plus chlorothalonil	Tattoo C	Bayer	61EC
propiconazole	Tilt, Propimox	Syngenta, Dow Agrosciences	3.6F
thiophanate M (thiophanate methyl)	Topsin M	Cerexagri	70WSB
TPTH (triphenyltin hydroxide)	Super-tin	Griffin	80WP
trifloxystrobin	Flint	Bayer	50WDG

ABBREVIATIONS:

DF = dry flowable, DG = dispersible granules, EC = emulsifiable concentrate, F = flowable suspension, LC = liquid concentrate, SC = soluble concentrate, WP = wettable powder, WSB = water soluble bag.

*The number preceding the type of formulation for *copper* products indicates the percentage or amount of *metallic copper* in the product. For example, "53WP" describes a wettable powder product that is 53 percent metallic copper, and "4.5F" describes a flowable product containing 4.5 lbs. of metallic copper per gallon.

FORMULATION NOTES:

Fungicides are sold commercially as a mixture of active ingredient (that which kills the fungus) and other substances, (i.e., carriers, diluents, solvents, wetting agents, emulsifiers, etc.). The *formulation* indicates the portion of the product that is active ingredient and the physical form of the product. For WP and DG formulations, the number before the abbreviation indicates the percentage of the product that is active ingredient. For F, LC, and EC formulations, the number before the abbreviation indicates the amount of the product that is active ingredient. For example, "50WP" describes a wettable powder that is 50% active ingredient, and "4F" describes a flowable product that contains 4 pounds of active ingredient per gallon of product.

Preharvest Intervals (days) and Re-Entry Intervals for Fungicides Registered for Use on Midwest Vegetables in 2002*

	Acibenzolar-S-methyl	Azoxystrobin	Benomyl	Chlorothalonil	Fixed Copper	Fosetyl Aluminum	Harpin	Iprodione	Mancozeb	Maneb	Mefenoxam	Myclobutanil	Thiophanate methyl	Trifloxystrobin	Triphenyltin Hydroxide	Ziram
Asparagus																
Phytophtora						110					0					
Rust									180			180				
Beans, Snap																
Anthracnose					0											
Bacterial blight					0											
Rust				7								0				
White mold/ gray mold			7					*					14			
Broccoli, Cabbage, Cauliflower																
Alternaria leafspot				0						7						
Black leg								0								
Black rot					0											
Downy mildew				0		3				7	7					
Carrot																
Alternaria leafspot				0				0								
Cercospora leafspot				0												
Cucumber, Muskmelon, Watermelon																
Alternaria leafspot		1		0					5							
Angular leafspot																
Anthracnose		1	1	0					5				0			
Bacterial fruit blotch					0											
Downy mildew		1		0		1/2			5		0			0		
Gummy stem blight		1		0					5							
Powdery mildew		1	1	0								0	0	0		
Onion, Dry bulb																
Botrytis (blast), purple leaf blotch		0		7		7		7	7	7						
Downy mildew		0		7		7			7	7	7					
Onion, Green bunching																
Botrytis (blast), purple leaf blotch				14						7						
Downy mildew				14						7	7					
Re-entry levels (REI) in hours	12	4	24	12	24	12	4	24	24	24	48	24	12	12	48	48

*Check label directions before applying any of these pesticides.

Preharvest Intervals (days) and Re-Entry Intervals for Fungicides Registered for Use on Midwest Vegetables in 2002*

	Acibenzolar-S-methyl	Azoxystrobin	Benomyl	Chlorothalonil	Fixed Copper	Fosetyl Aluminum	Harpin	Iprodione	Mancozeb	Maneb	Mefenoxam	Mycloutanil	Thiophanate methyl	Trifloxystrobin	Triphenyltin Hydroxide	Ziram
Asparagus																
Phytophtora						110					0					
Rust									180			180				
Beans, Snap																
Anthracnose					0											
Bacterial blight					0											
Rust				7								0				
White mold/ gray mold			7					*					14			
Broccoli, Cabbage, Cauliflower																
Alternaria leafspot				0						7						
Black leg								0								
Black rot					0											
Downy mildew				0		3				7	7					
Carrot																
Alternaria leafspot				0				0								
Cercospora leafspot				0												
Cucumber, Muskmelon, Watermelon																
Alternaria leafspot		1		0					5							
Angular leafspot																
Anthracnose		1	1	0					5				0			
Bacterial fruit blotch					0											
Downy mildew		1		0		1/2			5		0			0		
Gummy stem blight		1		0					5							
Powdery mildew		1	1	0								0	0	0		
Onion, Dry bulb																
Botrytis (blast), purple leaf blotch		0		7		7		7	7	7						
Downy mildew		0		7		7			7	7	7					
Onion, Green bunching																
Botrytis (blast), purple leaf blotch				14						7						
Downy mildew				14						7	7					
Re-entry levels (REI) in hours	12	4	24	12	24	12	4	24	24	24	48	24	12	12	48	48

*Check label directions before applying any of these pesticides.

Disease Diagnosis

Management of plant parasitic nematodes hinges on detection and population density estimation. Soil analysis for presence and quantity of plant parasitic nematodes from a lab with a trained nematologist is the first step prior to selecting a field for vegetable production. Root-knot nematodes (*Meloidogyne* spp.) and soybean cyst nematode (*Heterodera glycines*) are the most important nematode pests commonly found in the midwest. Predictive yield loss models are present for *Meloidogyne incognita* (root-knot) where basic biology information is known. Economic thresholds have been published for certain vegetable-nematode interactions.

Disease-Resistant Varieties

Resistance to all species of *Meloidogyne* except *M. hapla* is available with the Mi gene in tomato, but few other vegetable crops presently have resistant genes for plant parasitic nematodes. Nematode resistance in tomatoes is indicated by the "N" designation. Resistant varieties should be used whenever possible to reduce yield loss. It is important to have multiple disease resistance genes when more than one important pathogen is present in a field, such as with tomatoes where root-knot nematodes, *Verticillium*, and *Fusarium* can interact.

Crop Rotation

Plant parasitic nematodes survive overwinter in the soil or in association with plant material. Crop rotation and weed control are very important in managing plant parasitic nematodes. Root-knot spp. have a very wide vegetable, field crop, and weed host range. Soybean cyst nematodes have a much narrower host range, but when both nematode species are present a rotation ideal for soybean cyst nematode reduction may favor buildup of root-knot spp.

Other Cultural Practices

Damage by plant parasitic nematodes can be minimized by adequate water and fertilizer. Plant parasitic nematodes reduce the plant root system's ability to take up water and nutrients, especially when nematode population density is high at planting. Adequate water and fertilizer does not reduce the nematode density but reduces plant stress and thus the symptoms of nematode damage.

Anything that moves soil can spread plant parasitic nematodes within fields and to other fields.

Chemical Control

Seedling diseases, root diseases, and vascular wilts caused by soilborne fungi and nematodes can be destructive problems in the field and greenhouse. Soil-applied fumigants or nematicides may help prevent serious losses to soilborne disease when used in conjunction with long-term management practices.

Soil fumigants are chemicals that, when injected into the soil, emit toxic fumes that penetrate air spaces in soil in sufficient concentration to kill microorganisms. They must be sealed into the soil with water or a plastic tarp to ensure that a lethal concentration and exposure time are reached. Because fumigants are harmful to all living plants, a period of 2 weeks to 2 months must be allowed between treatment and planting in order to avoid crop damage. Several non-fumigant nematicides are available for several vegetable crops. These generally are systemic compounds that also may provide good insect control.

A number of different factors affect the performance of these products, including soil temperature soil moisture, soil tilth, organic matter, soil type, and time of application. Consult the product label for specific details on safe handling and application methods.

A brief description of several common soil treatments is given in the table on page 43.

Plant Parasitic Nematode Management Strategies (cont.)

Chemical	Fumigant/-Nematicide	Application	Plant Back Time	Crops	Comments
Methyl Bromide	F	Preplant, tarped or mulched for 24 to 48 hours	10 to 14 Days	Most vegetables	Formulations with 98% methyl bromide and 2% chloropicrin are appropriate for nematode control.
Mocap ethroprop	N	Soil only. Applied with water by soil injection, sprinkler system, flood irrigation, over soil surface with sprinkling can.		Cabbage, sweet corn, cucumbers, potatoes, sweet potatoes, snap beans, lima beans	Mobile in sandy soil. Crop injury can occur if used in furrow.
SMDC; Sodium Methydithio carbamate (Vapam, etc.)	F	Preplant Tarped. Don't enter within 48 hours.	14-21 days after treatment	General use fumigant	Vapam is more effective when applied with considerable water.
Vydate	N	Soil and foliage treatment	NA	Carrot, celery, cucurbits, eggplant, pepper, potato, sweet potato, tomato	Foliar applications are not effective for moderate and high populations of nematodes.
Telone	F	Soil treatment only	2 to 3 weeks	Most vegetables	Formulations with high percentages of chloropicrin are needed to control soilborne fungal diseases.
Nemacur, fenamiphos	N	Soil treatment only	NA	Cabbage, brussels sprouts, bok choy, okra, garlic	

F = Fumigant
N = Nematicide

Slug and Snail Control

Slugs and snails occasionally cause serious damage to seedlings, tender, low-growing leafy vegetables; or ripening fruit that are on the ground. Feeding damage, hollowed-out areas, can be found anywhere on fruit, but is usually concentrated near the stem. Slugs leave a telltale slime trail (silvery trail) behind on the surface of fruit or leaves. Slugs and snails are active at night or cloudy days.

Slugs and snails favor continuously moist soil and organic mulch. Their eggs are laid in groups in moist soil, and they use the organic mulch to overwinter. Slugs can complete their entire life cycle in a field.

If slugs are a problem, their hiding places, i.e., boards, stones, weedy areas, should be eliminated. Heavy mulching will also create a favorable habitat for slugs and should be thinned so the soil can become warm and dry. This will reduce the number of slugs. Raised beds that can dry out more readily than flat beds reduce slug problems. Use of black plastic mulch will discourage slug build-up because it causes the soil to heat up and dry out.

As a last resort, metaldyhyde bait (Clean Crop, 3.5G 30-40 lb./A or 7.5 G 15-20 lb./A) can be used and is usually very effective. Follow label instructions carefully for application methods for each particular vegetable crop. Apply bait in evening after a rain or irrigation. For an organic alternative, diatomaceous earth can be spread around plants (a 1 inch high x 3 inch wide band). Control of slugs with diatomaceous earth has been poor to fair.

Crop Recommendations

Asparagus

Varieties

All male hybrids: Jersey Gem, Jersey Giant, Jersey Knight, and Jersey King.

Other hybrids: Atlas and Purple Passion (specialty markets only).

Open pollinated: Viking KB3, Mary Washington.

Hybrid varieties have improved vigor, disease tolerance, and higher yields, and are grown from seeds or crowns. Order well in advance.

Planting, Spacing, Cultivating

Crowns: Use only 1-year old crowns. Transplant April 15 to May 15. Use 4- to 5-foot rows with crowns 12 to 16 inches apart. Set the crowns in 8-inch furrows in light soils and 5- to 6-inch furrows in heavy soils. Cover with 2 to 3 inches of soil. Select deep, well-drained sandy loam soils. Hybrids should be planted slightly deeper. Start cultivating when spears begin to emerge, and continue periodically until furrows are level at end of first season.

Seedling transplant: 10- to 14-week old seedling transplants can be mechanically transplanted. Apply 4 oz. of transplant solution (10-52-17 or 9-45-15) to each transplant. Transplant in either spring (early May) or fall (early to mid-September).

Age for Harvesting

Harvest only 2 or 3 times in spring 1 year after transplanting. Thereafter, harvest for about 2 months in the spring. Allow the ferns to grow vigorously after this period to accumulate food reserves for the next season. As much care should be put into maintaining a healthy fern as into harvest.

Fertilizing

Lime: To maintain a soil pH of 6.7 to 7.0. If possible, apply lime the year before planting.

Preplant: N, 70 lb. per acre; P_2O_5, 25 to 200 lb. per acre; K_2O, 0 to 250 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. Broadcast the fertilizer, and plow it under when preparing the land for the planting furrows. Before planting the new crown, apply 100 lb. per acre of 8-32-0, or similar high phosphate starter fertilizer, in the bottom of the trench. Cover with 1 inch of soil before setting crowns.

Yearly: Each year after harvest, apply 50 lb. N per acre by broadcasting and incorporate by lightly tilling. No P_2O_5 or K_2O is needed provided adequate fertilization was achieved prior to planting.

DISEASES Controlled	Treatment	Comments
Fusarium crown and root rot	Dip roots in a solutions of Manzate 75DF at 1 lb. per 100 gal. or Manex II at 0.8 qt. per 100 gal.	Obtain crowns from a reliable source. Avoid fields with a history of crown and root rot. Disease is promoted by acid (low pH) and poorly drained soil.
Rust and leaf spot (Cercospora)	Dithane or Penncozeb at 2 lb. per acre for dry (WP, DF, or DG) formulations or 1.6 qts. per acre of flowable (F) formulations.	Apply protective fungicides after harvest at 7-10 day intervals. Protection of ferns during summer months is essential for good yields the following season. 180 day PHI.
	Nova 40W at 5 oz. per acre.	**Rust only.** Begin applications to the developing ferns after harvest. Repeat on a schedule of less than 14 days. 24 hr. REI. 180 day PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Phytophthora crown and spear rot	Ridomil Gold 4E at 1 pt. per acre over bed.	Apply 30-60 days before harvest. Make second application just before harvest. 1 day PHI.
	Aliette WDG 5 lb. per acre.	Apply once per season to fully expanded leaves. 110 day PHI.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Devrinol 50DF	4 lb. per acre on light-colored soils (less than 2% organic matter); 8 lb. on other soils.	Incorporate 1 to 2 in. before weed emergence. Prior to planting succeeding crops, deep moldboard or disc plow. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months after using Devrinol.
Karmex 80DF	1-2 lb. per acre on light-colored soils (less than 2.0% organic matter); 2-4 lb. Karmex on other soils. Use at least 25 gal. of water per acre.	Use after tillage or chopping fern in the spring and again after harvest, if necessary. Apply before weeds emerge. Do not exceed 6 lb. per acre per year. 6-8 wks. residual activity. DO NOT apply to young plants during first year.
Sencor 4F or 75DF	1 to 2 qt. per acre of 4F. 1.3 to 2.7 lb. per acre of 75DF.	Established plantings only. Apply after tillage or chopping fern in spring and again after harvest before fern emergence, if necessary. Apply before weeds emerge. Total dosage may not exceed 2 lb. a.i. per acre per year. 2 sprays are necessary for season-long sandbur control. 6-8 wks. residual. 14 day PHI.
Sinbar 80W	1.5 lb. per acre on coarse soils and 2.5 lb. per acre on other soils. Do not use on soils with less than 1% organic matter. Use lowest rate on sandy or sandy-loam soils.	Apply prior to spear emergence in spring or after clean cutting. Do not use more than 1.5 lb. per acre at one time, or more than 2.5 lb. per acre per year. Do not plant any other crop than asparagus within 2 years of herbicide application. 8-12 wks. residual activity. For seedlings apply 300 lb. per acre activated charcoal in a 1-in. band over rows at planting. 5 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE (cont.)		
Solicam 80DF	2.5 to 5 lb. per acre.	Apply to asparagus established at least 1 year or more. Apply in fall after cropping fern or in spring before emergence. Use lower rate on coarse, sandy soil. Apply only once per season. Gives 3 to 4 months of residual activity. Suppresses nutsedge.
Trifluralin (4lb/gal)	1 to 1.5 qt. per acre.	Established plantings only. Use higher rates on heavier soils. Apply and incorporate 1 to 2 in. early in spring when spears are at least 4 in. below soil surface. 4-6 wks. residual activity.
POSTEMERGENCE		
Formula 40	1.5 to 2 pt. per acre.	Spray on emerged weeds before, during, or after the harvest season. The spray during harvest season should be made immediately after harvest to minimize injury. Use drop nozzles for treatments after harvest to avoid spraying the fern.
Stinger 3EC	8 to 11 fl. oz. per acre.	Apply to emerged broadleaf weeds. Do not apply more than 2/3 pt. per season. 48 hour PHI.
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Do not apply more than twice per season. Use high rate on quackgrass. 1 day PHI.
Fusilade DX 2E	8 to 12 fl. oz. or 16 to 24 fl. oz. per acre if asparaguswill not be harvested within 12 months. Include 1 to 2 pt. COC or 0.5 to 1 qt. nonionic surfactant per 25 gal. spray solution.	Do not exceed 48 fl. oz. per acre per season or 72 fl. oz. per acre per season if asparagus will not be harvested within 12 months. At least 14 days between application. 1 day PHI.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply before crop emergence or after last harvest. RUP. 6 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
NON-SELECTIVE HERBICIDES (cont.)		
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26-40 fl. oz. of 3.7 lb. ae/gal.; 24-36 fl. oz. of 4 lb. ae/gal.; 1.2-1.8 lb. of 64.9% ae WSG.	Apply at least 7 days before first spears emerge in spring or immediately after the last harvest when all spears are snapped off. If spears are allowed to regrow, delay application until ferns have developed. Delayed treatments must be applied as a directed or shielded spray. Direct contact of the spray with asparagus fern may result in serious crop injury. These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Asparagus beetles and cutworms	*For control on spears during harvest, to prevent egg laying and feeding injury:*	
Thresholds **Harvest** ***Asparagus beetle:*** 5-10% plants infested or 2% of spears w/ eggs ***Cutworms:*** 5% of crowns infested **Fern** ***Asparagus beetle:*** 10% defoliation or 50% of plants with larvae **Fall** ***Cutworms:*** 1 larva/20 plants	Sevin 80SP at 1.25 to 2.5 lb., or 50WP at 2 to 4 lb. per acre, or XLR Plus at 1 to 2 qt. per acre, or 5B at 40 lb. per acre.	Do not treat more than once every 3 days. **Bait for cutworms only.** 1 day PHI.
	OR	
	Lorsban 4E at 2 pt. per acre.	Do not make more than 1 pre-harvest application. Broadcast with ground equipment. 1 day PHI.
	OR	
	Malathion 57EC at 2 pt. per acre.	**Not for cutworms.** 1 day PHI.
	OR	
	LannateLV at 1.5 to 3 pt. or 90SP at 0.5 to 1 lb. per acre.	High rate for white cutworm. 1 day PHI.
	OR	
	Methoxychlor 2EC at 2 to 4.5 qt. per acre.	**For beetle control.** 3 day PHI.
	OR	

INSECTS CONTROLLED	TREATMENT	COMMENTS
Asparagus beetles and cutworms (cont.)	Pounce 3.2EC at 2 to 4 fl. oz./or 25 WP at 3.2 to 6.4 fl. oz. per acre.	Do not exceed 4 applications of Pounce per season. 1 day PHI.
	For control on seedlings and fern growth after harvest is over (use lower rates for seedlings):	
	Sevin 80SP at 2.5 to 5 lb., or 50WP at 4 lbs., or XLR Plus at 1 to 2 qts. per acre.	Apply after harvest has stopped. Do not treat more than once every 3 days.
	OR	
	Lannate LV at 1.5 to 3 pt. or 90SP at 0.5 to 1 lb. per acre.	Apply after harvest has stopped.
	OR	
	Ambush 2EC at 6.4 fl. oz., or 25WP at 6.4 oz. per acre.	Do not exceed 0.4 lb. a.i. per acre per season.
	OR	
	Lepinox at 1 to 2 lb. per acre.	0 day PHI.

Broccoli, Cabbage, Cauliflower, and Brussels Sprouts

BROCCOLI Varieties	Maturity	Comments
Leprechaun	Early	Large beads, slightly domed
Regal	Early	Medium to small beads, firm domed heads, side shoots
Green Comet	Early	Excellent center head and large side shoots
Emperor	Early-Mid	Few side shoots
Green Valiant	Mid	Small beads, firm head
Premium Crop	Mid	Large center heads, few side shoots
Goliath	Mid	Large, tight heads
Pinnacle (Trial only)	Mid	Small beads, firm heads
Marathon	Late	Domed
Eureka (Fall trial only)	Late	Small beads, very domed
Arcadia (Fall trial only)	Late	Small beads, very domed

CABBAGE Varieties	Season	Head Size	Yellows Resistance	Remarks
Green:				
Stone Head	Very Early	Small	No	Solid head for an early type.
Head Start	Early	Medium	No	Excellent field holding for an early type.
Charmont	Early	Small	Yes	
Conquest	Main	Medium	Yes	
Gourmet	Main	Medium-Large	Yes	Fair to good holding ability, moderately thrips susceptible.
Bronco	Late	Medium	Yes	
Green Cup	Main	Medium-Large	Yes	
Blue Pak	Main	Medium-Large	No	Good tip burn tolerance, very thrips tolerant.
Cheers	Late	Large	Yes	
Rio Verde	Late	Large	Yes	
Red:				
Red Acre	Main	Small	No	A firm head, open pollinated.
Regal Red	Early	Medium	No	Early for a red cabbage.
Ruby Perfection	Late	Small	No	Deep red color, thrips tolerant.

CAULIFLOWER Varieties	Season	Comments
Snow Crown-F_1 Hybrid	Early	Good and reliable for spring and early fall production.
Fremont F_1	2nd Early	
Snowball Y improved op	Main	Forming heads should be blanched.
Andes op	Main	Forming heads should be blanched.
White Sails F_1	Main	Forming heads should be blanched.
Self-Blanche op	Late	No tying necessary if plants are fertilized properly.
Silver Streak	Late	For fall harvest.

For Trial Only: Cashmere (Early), Candid Charm (2nd Early), Cumberland (Main), Majestic (Early)

Spacing

Cabbage for Market: Rows 2 to 3 ft. apart. Plants 12 to 15 in. apart in row.
Cabbage for Kraut: Rows 3 ft. apart. Plants 18 in. apart in row.
Broccoli: Rows 3 ft. apart. Plants 12 to 18 in. apart in row.
Cauliflower: Rows 3 ft. apart. Plants 15 to 18 in. apart in row.
Raised beds (6 in. high, 40 in. wide, with 2 rows 11 in. apart on beds) may be desirable under certain conditions.

FERTILIZING

Lime: To maintain a soil pH of 6.0 to 6.5.

Preplant: N, 120 lb. per acre if soil organic matter less than 3% and 80 lb. if soil organic matter greater than 3%; P_2O_5, 25 to 200 lb. per acre; K_2O, 0 to 250 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. Set each plant with 1 cup (8 oz.) of starter solution. See p. 3 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.

The Cole crops, particularly cauliflower, are responsive to B on soils of low organic matter, sandy soils, or where the pH is greater than 7.0. If B is needed, apply 1 to 2 lb. B per acre broadcast. Soil test and/or perform plant analysis on the previous crop to be sure B is needed. High soil B can be detrimental to rotational crops such as sweet corn, peas, or beans.

Sidedress N: Apply 60 lb. N per acre 2 to 3 weeks after setting the transplants and rapid growth has begun. Eliminate the sidedressing if following soybeans. If leaching likely on sandy soils, apply an additional 30 lb. N as a sidedress. Avoid excessive N fertilization with broccoli as it can cause too rapid growth and a hollow flower stalk.

HARVESTING

Broccoli: Harvesting is done by hand while the head is still compact and before the flowers open. The central heads should be dark blue or green and 4 to 6 in. across when mature. If harvesting too late or when the heads are overmature, woodiness in the stems will develop. Depending upon your marketing requirements, the main head is cut with 8 to 10 in. of stem. Sometimes a second harvest of side shoots can be obtained. Broccoli for processing should be cut with less attached stem (6 to 7 in.) and with few or no leaves. Fresh market broccoli should be cut longer, with little trimming. Quality of broccoli is based upon the degree of compactness, leafiness, trimness of heads, damage, and freedom from insect and extraneous debris.

Cauliflower: When ready to harvest, the heads should be compact and clear white. Heads become discolored and develop an undesirable flavor when exposed to sunlight. The longest leaves are normally tied loosely together over the head to "blanch" and prevent the head from being exposed to the sun. The desirable size for harvest is a diameter of approximately 6 in. Larger heads usually cannot be obtained by delaying harvest. Instead, proper cultivar selection and plant spacing should be considered. Cauliflower should be hand-harvested and cut with 1 or 2 whorls of leaves to protect the head.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Alternaria leaf spot	3-4 year crop rotation.	Rotate to non-cruciferous crops.
	Bravo 500 at 2.25 pt. per acre, Bravo Ultrex at 1.4 lb. per acre, or Bravo WS at 1.5 pt. per acre.	Apply protective fungicides at the first sign of disease, and repeat at 7-10 day intervals. Begin fungicide applications sooner if field has a history of this disease. 7 day PHI for chlorothalonil and maneb fungicides.
	Maneb 80W at 1.5 to 2 lb. per acre or Manex at 1.2 to 1.6 qt. per acre.	
Black leg	3-4 year crop rotation.	Rotate to non-cruciferous crops.
	Plant disease-free seeds or transplants.	Hot water seed treatment helps eliminate seed-borne pathogens.
	Rovral at 2 pt. per acre for flowable (F) formulations or 2 lb. per acre for dry formulations **(broccoli only)**.	Apply to young plants (2 to 4 leaf stage) immediately after thinning. A second application may be made until the day of harvest. 0 day PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Black rot	3-4 year crop rotation.	Rotate to non-cruciferous crops.
	Plant disease-resistant cabbage varieties.	Resistant varieties include: Bravo, Green Cap, Olympic, Solid Blue #770, Show Boat.
	Plant disease-free seeds or transplants.	Hot water seed treatment helps eliminate seed-borne pathogens.
	Apply 1 to 2 lb. of fixed copper per acre. Repeat applications at 5-7 day intervals if wet weather persists early in the season.	Applications of copper may slow the spread of black rot.
Club root	Plant only disease-free transplants.	Avoid poorly drained soils with a history of club root.
	7 or more year crop rotation.	Rotate to non-cruciferous crops.
	Terrachlor 75W at 0.5 pt per plant of transplant solution (2 lb. per 25 gal.), 37 fl. oz. per 1000 ft. of row banded (30 lb. per 25 gal.), or 40 lb. per 30 gal. broadcast.	Serious losses can be avoided by raising soil pH to 7.2 - 7.5.
Downy mildew	2-3 year crop rotation.	Rotating to non-cruciferous crops may reduce pathogen populations and increase fungicide efficacy.
	Plant disease-resistant broccoli varieties.	Resistant broccoli varieties include: Citation, Everest, Mariner.
	Apply Ridomil Gold Bravo (1.5 lb. per acre) at the first sign of disease.	Second and third applications may be required and should be applied at 14-day intervals. 7 day PHI.
	Apply Bravo Ultrex at 1.4 lb. per acre, Agronil 720 or Bravo Weather Stik or Equus 720 at 1.5 pt. per acre, Bravo 500 at 2.25 pt. per acre.	Begin applications after transplanting or emergence. 7 day PHI.
	Apply Aliette at 2 to 5 lb. per acre.	When Aliette is applied with other labeled fungicides other than copper, use 2 to 3 lbs. When used alone, apply Aliette at 3 to 5 lb. per acre. 3 day PHI.
Fusarium yellows	Plant yellows-resistant varieties.	Many resistant varieties are available.
Powdery mildew	Apply Microthiol Special at 3 to 10 lb. per acre. In early leaf stage.	Repeat application every 10 to 14 days or as needed. 24 hour REI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Seed Contamination	Use 1 oz. Captan 50WP per 100 lb. of seed.	Most seed companies distribute treated seeds. Hot water treatment is important to help prevent black leg and black rot.
Wirestem	Terrachlor 75W at 12.2 to 18.4 fl. oz. per 1000 ft. of row banded (10 to 15 lbs. per 35 gal.) or 15 to 20 lb. per 50 gal. broadcast at time of seedling germination or immediately thereafter.	Raise seedlings in seed beds that are disinfected by steam or chemical fumigants.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Command 3ME	0.67 pt. per acre for direct seeded; up to 1.3 pt. per acre for transplants.	**Cabbage only.** Apply before seeding or transplanting, or after seeding before crop emerges. 45 day PHI.
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply immediately after seeding or transplanting. Use 50-mesh or larger screens. Not effective on muck soil and other high organic soils.
Devrinol 50DF	2 lb. per acre on light-colored soils (less than 2% organic matter), 4 lb. on other soils.	Incorporate 1 to 2 in. deep before seeding or transplanting. After harvest or prior to planting succeeding crops, a deep moldboard or disc plowing operation must be done. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months after application.
Trifluralin (4 lb./gal.)	1 pt. per acre on light-colored soils (less than 2% organic matter), 1.5 pt. on darker soils.	Apply before planting, and incorporate immediately into soil by double discing or with other equipment to give thorough mixing 3 to 4 in. deep. Not effective on muck and other high organic soils.
oxyfluorfen 2L or 1.6E	1 to 2 pt. per acre of 2L or 1.25 to 2.5 pt. per acre of 1.6E in a minimum of 20 gal. water. Use lower rate on coarse textured soils.	Apply after completion of soil preparation but **prior** to transplanting. Transplant within 7 days of application. **Do not** use on direct seeded broccoli, cauliflower, and cabbage, or over the top of existing plants. **Not for Brussels sprouts.**

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE (cont.)		
Prefar 4E	5 qt. per acre on light-colored sandy soils (less than 1% organic matter), 6 qt. on other soils.	Apply before planting, and incorporate 1-2 inches. Or apply after seeding and before crop emerges, and irrigate within 24 hours.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 3 pt. per acre per season. 30 day PHI.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Some fomulations allow spot spray application in cabbage - check label. Apply to emerged weeds before seeding or transplanting, or after seeding but before crop emergence. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before planting in spring or after final harvest. The rates are for annual weeds at volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Root maggots	Cabbage maggot injury is usually more severe when fields have decaying organic matter present, such as plowed down cover crop, or when cool, wet conditions prevail.	
	For use in transplanting water, mix any one of the following in each 50 gal. of water. (Refer to Comments or product label regarding drench application):	The transplant mixture (insecticide plus water) application will require about 200 to 300 gal. of water per acre, based upon the number of plants set per acre.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Root maggots (cont.)	Lorsban 4EC as follows: cauliflower at 1.6 to 2.4 fl. oz. per 1000 linear feet of row; broccoli, Brussels sprouts, and cabbage at 1.6 to 2.75 fl. oz. per 1000 linear feet of row.	Apply as a water-based spray directed to base of the plants immediately after setting in field, using a minimum of 40 gal. of total spray per acre. Do not apply as a foliage application. 30 day PHI.
	OR	
	Diazinon AG500 at 4 to 6 fl. oz. or Diazinon 50WP at 0.25 to 0.5 lb. in 50 gal. of water (for drench application).	Transplant water treatments may reduce stands due to plant stress at time of transplanting. Make drench application at the rate of 1/2 to 1 cup per plant, either by hand or tractor-mounted sprayer with drop nozzles to direct spray to base of plant. In some areas cabbage maggots are exhibiting resistance to diazinon, resulting in control failures.
Caterpillars Imported cabbageworms Cabbage loopers Diamondback moth larvae Cross-striped cabbageworm	*Use when tiny worms and/or loopers first appear:*	Use of some insecticides may reduce populations of beneficial insects that suppress caterpillar populations.
	Bacillus thuringiensis (MVP, Javelin, Dipel, Biobit, Agree, Xentari, Lepinox, Ketch). Follow label directions.	Begin applications when worms are small. Use of Bt products will help conserve beneficial insects. 0 day PHI.
	OR	
	Warrior 1EC at 1.9 to 3.8 fl. oz. per acre.	Do not exceed 1.92 pts. per acre per season. 1 day PHI.
	OR	
	Capture at 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 32 fl. oz. per acre per season. 7 day PHI.
	OR	
	SpinTor 2 SC at 1.5 to 6 fl. oz. per acre.	Do not apply more than 29 fl. oz. per acre per season. Observe resistance management restrictions. 1 day PHI.
	OR	
	Proclaim 5WDG at 2.4 to 4.8 oz. per acre.	Do not make more than 2 sequential applications. Allow at least 7 days between applications. 7 day PHI.
	OR	
	Thiodan, Endosulfan, or Phaser 50WP at 1.5 to 2 lb. or 3EC at 1 to 1.3 qt. per acre.	No more than 4 applications per year. Cabbage and broccoli, 7 day PHI; Brussels sprouts and cauliflower, 14 day PHI.
	OR	
	Lannate LV at 1 to 3 pt. or 90SP at 0.5 to 1 lb. per acre. Add wetting agent.	Also controls aphids. Cabbage, 1 day PHI; cauliflower, broccoli, and Brussels sprouts, 3 day PHI.
	OR	

Thresholds

Cabbage

Stage Infested	% Plants
Seedbed	10%
Transplant to cupping	30%
Cupping to early head	20%
Mature head	10%

Broccoli and Cauliflower

Seedbed	10%
Transplant to 1st flower or curd	50%
First flower or curd to maturity	10%

INSECTS CONTROLLED	TREATMENT	COMMENTS
Caterpillars (cont.) Imported cabbageworms Cabbage loopers Diamondback moth larvae Cross-striped cabbageworm	Pounce 3.2EC at 2 to 8 fl. oz., or 25WP at 3.2 to 12.8 fl. oz. per acre. OR Ambush 2E at 3.2 to 6.4 fl. oz., or 25WP at 3.2 to 12.8 oz. per acre. OR	Do not exceed 0.8 lb. a.i. per acre per season to broccoli, cauliflower, or Brussels sprouts, or 1 lb. a.i. per acre per season for cabbage. 1 day PHI.
	Larvin 3.2AF at 16 to 40 fl. oz. per acre. OR	Do not exceed 240 fl. oz. per acre per season. **Not for Brussels sprouts.** 7 day PHI.
	Asana XL at 5.8 to 9.6 fl. oz. per acre. OR	Do not exceed 0.4 lb. a.i. per acre per season. **Not for Brussels sprouts.** 3 day PHI.
	Orthene/Address 75S at 1.3 lb. per acre. OR	**Brussels sprouts and cauliflower only.** Also for aphids. 14 day PHI.
	Dibrom 8EC at 2 pt. per acre. OR	Use 1 pt. for aphids. Refer to label. 1 day PHI.
	Ammo 2.5EC at 2.5 to 5 fl. oz. per acre. OR	Do not exceed 0.6 lb. a.i. per acre per season.1 day PHI.
	Scout X-Tra 0.9EC at 2.28 to 2.84 fl. oz. per acre. OR	**Broccoli only.** Do not exceed 27 fl. oz. per acre per season. 5 day PHI.
	Fury 1.5EC or Mustang 1.5EW at 2.4 to 4.2 fl. oz. per acre. OR	**Cabbage only.** 1 day PHI.
	Avaunt 30WDG at 2.5 to 3.5 oz. per acre.	**Not for Brussels sprouts.** Do not exceed 14 oz. per acre per season. 3 day PHI.
Aphids **Thresholds** *Broccoli and Cauliflower* Before heading - 100/plant After heading - 5/plant *Cabbage* 20% plants infested	Conserve natural enemies.	Limit the use of insecticides to conserve predators and parasites.
	Admire 2F at 10 to 24 fl. oz. per acre. OR	Do not exceed 0.5 lb. a.i. of Admire or Provado per acre per season. 21 day PHI.
	Provado 1.6F at 3.75 fl. oz. per acre. OR	0 day PHI.
	Diazinon AG500 at 1 pt. per acre. OR	7 day PHI, 21 day PHI for cabbage.
	Dimethoate at 0.75 to 1.5 pt. per acre. OR	Repeat applications as necessary. **Not for Brussels sprouts.** 7 day PHI.
	Metasystox-R 2SC at 1.5 to 2 pt. per acre, or up to 3 pt. per acre for cabbage. OR	No more than 3 applications per season. 7 day PHI, 10 day PHI for Brussels sprouts.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids (cont.)	M-Pede at 1 to 2% by volume.	Must contact aphids to be effective. 0 day PHI.
	OR	
	Orthene, Thiodan, or Dibrom as described for cabbage caterpillars.	Follow all harvest restrictions (PHI), warnings, and precautions on label.
	OR	
	Capture2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 32 fl. oz. per acre per season. 7 day PHI.
Flea beetles	Any of the materials applied for worm control will control flea beetles, except *Bacillus thuringiensis* (MVP, Javelin, Dipel, etc.).	Examine plants soon after they are set in the field to determine need for control.
	OR	
	Sevin 50WP at 1 lb., 80SP at 0.6 lb., or XLR Plus at 1 to 2 qt. per acre.	3 day PHI.
	OR	
	Mustang 1.5EW at 2.39 to 4.26 fl. oz. per acre.	**Cabbage only.** Do not exceed 25.6 fl. oz. per acre per season. 7 day PHI.
	OR	
	Provado 1.6F at 3.75 fl. oz. per acre.	Do not exceed 18.75 fl. oz. per acre per season. 0 day PHI.
	OR	
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 32 fl. oz. per acre per season. 7 day PHI.
Thrips	Plant resistant varieties, such as Rio Verde, Ruby Perfection, Bantly, Zerlina, Manrico, Brutus, Stonar, Starski, Bravo, Little Rock, SuperKraut, Rio Granda, Titanic 90, King Cole, and others.	Some varieties of cabbage are resistant to thrips.
	Ammo 2.5 EC at 3.75 to 5 fl. oz. per acre.	Do not exceed 0.6 lb. a.i. per acre per season. 1 day PHI.
	OR	
	Dimethoate at 0.75 to 1.5 pts. per acre.	7 day PHI.
	OR	
	Fury 1.5EC or Mustang 1.5EW at 3.4 to 4.3 fl. oz. per acre.	**Cabbage only.** 1 day PHI.
	OR	
	Warrior 1EC at 2.56 to 3.84 fl. oz. per acre.	1 day PHI.
	OR	
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 32 fl. oz. per acre per season. 7 day PHI.

MUSKMELON Varieties	Season	Quality	Remarks
Athena	Early-Mid	Excellent	Medium net, oval very firm flesh
Eclipse	Mid-Late	Excellent	Heavy net, round, very firm flesh
Odyssey	Early-Mid	Excellent	Round to oval, firm
Starfire (HM 2608)	Mid-Late	Very Good	Very large fruit, good netting
Starship	Early-Mid	Very Good	Excellent size and net, uniform fruit
Superstar	Early	Good	Very large fruit, excellent netting

Promising Western cantaloupes for the Midwest: Don Carlos, Explorer, HyMark, Primo, Tastysweet, Veracruz.
Promising green flesh muskmelons: Makdimon, Passport, Galor 2, Galor 3.
Honeydew and Crenshaw melons for trial: Daybreak, Early Dew, Moonshine, Sunex 7051, Venus.

WATERMELON Varieties	Maturity (days)	Fusarium Wilt* Resistance	Color	Shape	Approx. wt. (lb.)
Seeded Watermelons					
Carnival	86	7	lt. green, striped	blocky	22-26
Crimson Sweet	88	--	green, striped	blocky round	20-30
Fiesta	88	9	dk. green, striped	blocky	22-26
Matador	95	--	dk. green	long oval	25-30
Regency	82	9	dk. green, striped	blocky oblong	18-22
Royal Majesty	90	--	green, thin stripes	long oval	30
Royal Sweet	85	7	lt. green, striped	blocky oval	20-25
Sangria	85	9	dk. green, striped	long blocky oval	20-26
Sultan	88	--	lt. green, striped	oblong	25-30
Summer Flavor 500	88	--	med. green, striped	blocky oblong	25-35
Summer Flavor 800	88	--	dk. green, striped	blocky oval	22-26
Seedless Watermelons**					
Crimson Trio	85	7	med. green, striped	globe	14-16
Freedom	88	--	lt. green, striped	blocky oblong	16-22
Genesis	85	--	dk. green, striped	round	15-18
Millionaire	90	7	lt. green, striped	oblong	13-20
Nova	85	--	dk. green, striped	round	14-16
Shadow	90	7	dk. green, striped	round oval	15-18
SS 5544	88	--	lt. green, striped	oblong, oval	
SummerSweet 5244	90	6	lt. green, striped	round oval	16-20
Tri-X-313	90	6	lt. green, striped	round oval	16-20
Yellow-fleshed Watermelons					
AU-Golden Producer	88	--	lt. green, striped	blocky round	20-30
Yellow Baby	68	--	lt. green, striped	round	9-12

Suggested Small Ice-box Variety: Jade Star
Seeded Varieties for Trial: Baron, Emperor

* **Fusarium Wilt Resistance Ratings for Watermelon:** A score of "9" indicates excellent resistance, a rating of "1" indicates little or no resistance. Black Diamond has a rating of 1. Cultivars with a resistance rating less than "6" should not be planted in fields with a history of Fusarium wilt. See Purdue Extension publication BP-19 for a more extensive list of wilt-resistant watermelon varieties.

** Pollinators must be planted with seedless varieties. Use a long watermelon such as Royal Jubilee, Royal Sweet, Sangria, or SF 500 as the pollinating variety. Crimson Sweet works well as a pollinator, but its fruit will be seeded and have a similar appearance to most seedless varieties.

A. CUCUMBER - Slicing Varieties	Season	Disease Resistance*
Dasher II	Early	1-2-3-4-5-6
General Lee	Main	3-4-5-6
Lightning	Very Early	3-4-6
Speedway	Very Early	1-2-3-4-5-6
Thunder	Very Early	3-4-6-7
For Trial Only: Jazzer		

B. CUCUMBER - Pickling Varieties	Season	Spine Color	Disease Resistance*
Calypso	Early to Mid	White	1-2-3-4-5-6
Carolina	Mid	White	1-2-3-4-5-6
Fancipak M	Early to Mid	White	1-2-3-4-5-6
Green Spear 14	Mid	White	1-3-4-5-6
Score**	Early	White	1-2-3-4-5

*Degree of resistance varies according to variety. Disease resistance codes are as follows: 1) angular leaf spot, 2) anthracnose, 3) cucumber mosaic virus, 4) scab, 5) downy mildew, 6) powdery mildew, 7) zucchini yellow mosaic virus.

** Machine harvest only.

SPACING

Muskmelons: Rows 5 to 7 ft. apart. Plants 3 to 5 ft. apart in row. 1 to 2 plants per hill. Plastic mulch is recommended. Clear mulch is suggested only for earliest plantings in northern areas.

Watermelons: Rows 6 to 12 ft. apart. Plants 3 to 6 ft. apart in row. One plant per hill. Plastic mulch is recommended.

Cucumbers: Rows 4 to 6 ft. apart. Plants 15 to 18 in. apart in row. Pickles (Machine harvest): Rows 18 to 20 in. apart. Plants 5 to 7 in. apart in row. Cucumbers should be planted after the danger of frost is past since they are not frost tolerant. For proper germination, soil temperature must be *above* 60°F. Planting too early when the soil is too cold and wet will result in poor seedling emergence.

FERTILIZING

Lime: To maintain a soil pH of 6.0 to 6.5. Muskmelon in particular is very sensitive to low soil pH and should be limed to 6.3 to 6.8. If your soil test indicates less than 70 ppm magnesium, use dolomitic limestone, or apply 50 lb. Mg per acre broadcast preplant incorporated.

Preplant: N, 40 to 60 lb. per acre; P_2O_5, 0 to 150 lb. per acre; K_2O, 0 to 200 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. For transplants, a starter solution at the rate of 1 cup (8 oz.) per plant is recommended. See p. 3 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting the starter solution can be eliminated.

Sidedress N: Apply 45 lb. N per acre in a band to either side of the row when plants are rapidly vining. At least half of the nitrogen should be in the nitrate (NO_3) form. For direct seeded watermelon, the preplant N application can be replaced by an early sidedressing of 40 lb. N per acre when plants show the first set of true leaves followed by the 45 lb. N rate at the rapid vining stage of growth. If heavy rains occur in June, 30 lb. N per acre should be applied through the irrigation system at fruit set (late June - early July).

For muskmelons and cucumbers grown on plastic mulch, the N rate can be reduced because N losses from leaching are greatly reduced. For this culture system, apply 50 lb. N per acre broadcast preplant over the row just prior to laying the plastic. Sidedress 30 lb. N per acre on either side of the plastic at vining when the plant roots have reached the edge of the plastic (mid June). If you are using trickle irrigation, then apply the 50 lb. N per acre preplant and apply 0.5 to 1 lb. N per acre daily or 3 to 6 lb. N on a weekly basis through the trickle system until fruit are about 2 inches in diameter.

IRRIGATION

Cucumbers: Maximum yields and fruit quality will only result if the plants receive adequate and timely moisture. Depending upon your soil type, approximately 1 to 2 in. of water per week is needed to obtain high quality cucumbers. An irregular water supply, particularly during blossoming and fruit development, can detrimentally affect fruit quality and result in increased nubins or hooked fruit.

Muskmelons: Muskmelon are moderately deep rooted and require adequate soil moisture with good drainage. Natural rainfall may not be adequate. Supplemental irrigation may be required, particularly in the early stages of growth. When irrigating, irrigate the soil in the effective root zone to field capacity. A good steady moisture supply is critical for good melon production. After melons have attained a good size, it is best if irrigation is reduced. Reduced irrigation at this time can in some cases increase the sugar content of the mature fruit. Excessive moisture during fruit ripening can result in poor fruit quality.

Watermelons: Watermelons are deep-rooted plants, so natural rainfall often is adequate, and irrigation may not be cost effective on heavier soils. Adequate soil moisture in the early growth stages will help to ensure vigorous growth and is also critical during blossoming and fruit development.

HARVESTING

Cucumbers: Unless a once-over mechanical harvester is being used, cucumbers should be harvested at 2-4 day intervals to prevent losses from oversized and overmature fruit. Desired harvest size ranges from 5 to 8 in. long and 1.5 to 2 in. in diameter for fresh market. If growing for a processor, be sure to understand the specific terms of their contract at the beginning of the growing season. Prices received are related to the quantity of fruit within specific size ranges as established by either USDA guidelines or by a processor.

Muskmelons: Harvesting is done manually, and great care must be exercised at picking to harvest only the physiologically mature plants. Fruits must be in the half or full slip state. Fruit harvested prior to the half slip stage will be too green and will not ripen properly. The shipping of undermature fruit has been a problem and should be avoided.

Watermelons: Harvesting watermelons at the correct stage of maturity is critical and difficult. While each cultivar is different, maturity can be determined in several ways. Ground spots changing in color from white to yellow, browning of tendrils nearest the fruit, ridges on the rind surface, and a hollow or dull sound when "thumped" all indicate correct maturity. Melons should be cut from the plant to avoid vine damage and prevent stem-end rot.

DISEASE MANAGEMENT WITH THE MELCAST SYSTEM

MELCAST is a disease warning system that can help Indiana farmers schedule their fungicide applications for control of certain diseases of watermelons and muskmelons. The system was developed by researchers in the Department of Botany and Plant Pathology at Purdue University. Using MELCAST each summer involves calling a toll free phone number to obtain the lastest assessment of disease risk based on local weather. Educational programs that address the system are conducted each winter by Purdue University Cooperative Extension Service specialists in plant pathology. For more information about MELCAST, contact Dan Egel (Southwest Purdue Agricultural Research Program) at 812-886-0198, or Rick Latin (Purdue Campus) 765-494-4639.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Alternaria leaf blight (muskmelon)	3-4 year crop rotation.	Rotation with non-cucurbit crops will significantly reduce the threat of Alternaria in future melon crops.
Use MELCAST for scheduling fungicide applications.	Bravo 500 at 2.75 to 4.25 pt. per acre, Bravo Ultrex or Equus DF at 1.8 to 2.7 lb. per acre, Bravo WS, Agronil 720 or Equus 720 at 2 to 3 pt. per acre, or Terranil Cu or Echo at labeled rates.	Apply protective fungicide beginning when vines touch within rows or at first sign of the disease. Use a 7-10 day application interval. 0 day PHI.
	OR	
	Dithane M45 or DF, or Penncozeb 75DF at 2 to 3 lb. per acre, Manex at 1.2 to 1.6 qt. per acre, or Maneb 75DF or 80WP at 1 to 2 lb. per acre.	24 hour REI. 5 day PHI.
	OR	
	Quadris 2.08SC at 11.0 to 15.4 fl. oz. per acre.	Do not apply Quadris more than one time before alternating with a fungicide with a different mode of action. 7 to 14 day application interval. 4 hour REI. 1 day PHI.
Angular leaf spot (cucumber and muskmelon)	Resistant varieties (cucumbers only).	Several cucumber varieties have genetic resistance to angular leaf spot.
	Kocide DF at 2 to 3 lb. per acre.	Apply copper bacteriacides at the first sign of disease. Alternate or tank mix with fungicides to maintain protection from other diseases. Sprays will result in marginal chlorosis of leaves. Kocide, 24 hour REI. Champion, 24 hour REI. 0 day PHI.
	OR	
	Champion WP at 2 to 3 lb. per acre.	
Anthracnose (cucumber, muskmelon, watermelon)	Resistant varieties (cucumbers only).	Many cucumber varieties have genetic resistance to anthracnose.
	3-4 year crop rotation.	Rotation with non-cucurbit crops will decrease the threat of anthracnose in future years.
Use MELCAST for scheduling fungicide applications.	Bravo 500 at 2.25 to 2.75 pt. per acre, Bravo Ultrex at 1.4 to 1.8 lb. per acre, Bravo WS or Agronil 720 at 1.5 to 2.0 pt. per acre, or Terranil Cu or Echo at labeled rates.	48 hour REI. 0 day PHI.
	OR	
	Dithane M45 or DF, or Penncozeb 75DF at 2 to 3 lb. per acre, Manex at 1.2 to 1.6 qt. per acre, or Maneb 75DF or 80WP at 1 to 2 lb. per acre.	5 day PHI.
	OR	

DISEASES CONTROLLED	TREATMENT	COMMENTS
Anthracnose (cucumber, muskmelon, watermelon) (cont.)	Quadris 2.08SC at 11.0 to 15.4 fl. oz. per acre.	Do not apply Quadris more than one time before alternating with a fungicide with a different mode of action. 7 to 14 day application schedule. 4 hour REI. 1 day PHI.
Bacterial fruit blotch	Plant uncontaminated watermelon seed.	The pathogen is primarily seed-borne (introduced with contaminated watermelon seed), but may overwinter on infested plant material in greenhouses and in the field.
	If fruit blotch has occurred in the past, sanitize the greenhouse thoroughly.	
	Contaminated fields should be fall-plowed and planted to crops other than melon or cucurbits for at least 2 years.	Muskmelons may be infected, but they do not appear as disease-prone as watermelons.
	Subsequent grain crops are suggested for the rotation so that broadleaf herbicides will kill volunteer watermelon seedlings in the spring.	
	In situations where fruit blotch threatens, applications of copper hydroxide at 10-14 day intervals beginning at fruit set may help reduce the rate of spread of the disease.	Copper applications may be effective in reducing losses only if the disease is diagnosed early, and sprays are applied before widespread infection has occurred. Repeated use of Copper may result in a reduction of watermelon yield. Copper will not provide acceptable control of fungal diseases such as anthracnose or gummy stem blight.
Bacterial wilt (cucumber and muskmelon)	A systemic insecticide (Furadan) should be incorporated into soil before transplanting. contact insecticides should be applied to seedlings before transplanting and then continued on a regular basis after the systemic insecticide loses effectiveness (2-3 weeks).	Control of this disease depends on control of striped and spotted cucumber beetles. Fields should be scouted regularly for the presence of beetles. Insecticides should be applied only when beetles are present. When large numbers are present, treatments may be required twice weekly.
Downy mildew (cucumber, muskmelon, watermelon)	Resistant varieties.	Several cucumber varieties have genetic resistance to downy mildew.
	Ridomil Gold Bravo at 2 lb. per acre, or Ridomil Gold MZ at 1.5 to 2 lb. per acre.	48 hour REI. Alternate with protective fungicide. 0 day PHI for Ridomil Bold Bravo, 5 days for MZ.
	OR	

DISEASES CONTROLLED	TREATMENT	COMMENTS
Downy mildew (cucumber, muskmelon, watermelon) (cont.)	Maneb 75 DF at 1 to 2 lb. per acre, or Dithane at 1.6 to 2.4 qt. or 2 to 3 lb. per acre.	48 hour REI. 5 day PHI.
	OR	
	Agronil, Bravo, Echo, Equus, or Terranil Cu at labeled rates.	See anthracnose for rates. 0 day PHI.
	OR	
	Quadris 2.08SC at 11.0 to 15.4 fl. oz. per acre.	Alternate with other fungicides, but not with Flint. 5 to 7 day application schedule. 4 hour REI. 1 day PHI.
	OR	
	Aliette at 2 to 5 lb. per acre. Use 2 to 3 lb. rate when tank mixed with another fungicide registered for use on curcurbits. Use 3 to 5 lb. rate when used alone.	Use 7 to 14 day interval. 12 hour PHI.
	OR	
	Flint at 4.0 oz. per acre.	Use a 7-14 day interval. Do not apply Flint more than one time before alternating with a fungicide with a different mode of action. Do not alternate with Quadris. 12 hour REI. 0 day PHI.
Fusarium wilt (muskmelon)	Use resistant muskmelon cultivars: Legend, Eclipse, and Superstar.	These cultivars have good resistance to strains of Fusarium found in Indiana and Illinois.
Fusarium wilt (watermelons)	Use watermelon cultivars with partial resistance: Royal Jubilee, Royal Star, Royal Sweet, and Sangria. Check table on page 57.	Rotation with non-cucurbit crops will decrease incidence of wilt.
Gummy stem blight (cucumber, muskmelon, watermelon)	3-4 year crop rotation.	Rotation with other crops will significantly decrease the threat of gummy stem blight in future years.
	Apply chorothonil products at rates listed under Alternaria leaf blight.	0 day PHI.
	OR	
	Apply mancozeb products at rates listed under Alternaria leaf blight.	24 hour REI. 5 day PHI.
	OR	
	Quadris 2.08SC at 11.0 to 15.4 fl. oz. per acre.	Do not apply Quadris more than one time before alternating with a fungicide with a different mode of action 7 to 14 day application schedule. 4 hour REI. 1 day PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Nematodes (muskmelon and watermelon)	Methyl bromide. OR Telone II or Telone C-35. OR Sodium methyl dithiocarbamate. OR Vydate L at 1 to 2 gal. per acre in 20 gal. water broadcast. Incorporate 2 to 4 inches.	Methyl bromide and Sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate gives adequate control when nematode populations are low to moderate and most of all product is applied under plastic mulch. Apply in spring before planting.
Phytophthora fruit and root rot	Crop rotations of 4 years or longer. Avoid fields with a history of the disease on curcurbits, eggplants, peppers and tomatoes.	No resistant variety is available. No adequately effective fungicide is available.
Powdery mildew (cucumber and muskmelon)	Use resistant varieties whenver possible.	Many cucumber varieties are resistant to powdery mildew. Muskmelon varieties resistant to powdery mildew include Athena, Legend and Eclipse.
	Nova 40 W at 2.5 to 5 oz. per acre. OR Benlate at 8 oz. per acre. OR Topsin 70WSB at 4 oz. per acre or Topsin 40W at 1/4 to 1/2 lb. per acre.	Make initial application 7-10 days before first harvest for muskmelon. Make a second application 2-3 weeks later. 0 day PHI for Noa, Topsin. 1 day PHI for Benlate. 24 REI for Benlate, Nova. 12 hour REI for Topsin.
	OR	The fungi which cause powdery mildew may become resistant to the systemic fungicides listed here unless precautions are taken. It is a good idea to always alternate between fungicides with different modes of action. Flint and Quadris have the same mode of action and must never be applied in back to back sequence. Similarly, Benlate and Topsin have the same mode of action. Nova has yet a different mode of action.
	Quadris 2.08SC at 11.0 to 15.4 fl. oz. per acre. OR	Alternate with other fungicides other than Flint. 5-7 day application interval. 4 hour REI. 1 day PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Powdery mildew (cucumber and muskmelon) (cont.)	Flint at 1.5 to 2.0 oz. per acre.	Use 7-14 day interval. Do not exceed two consecutive applications. Do not alternate Quadris. 12 hour REI. 0 day PHI.
Scab (cucumber)	Resistant varieties.	Several cucumber varieties are resistant to scab infection.
	3-4 year crop rotation.	Rotation will significantly reduce the threat of scab infection in subsequent cucumber crops.
	Bravo 500 at 2.75 to 4.25 pt. per acre, Bravo Ultrex at 1.8 to 2.7 lb. per acre, Bravo WS at 2 to 3 pt. per acre, or Terranil or Echo at labeled rates.	0 day PHI.
	OR	
	Dithane M45 or DF or Penncozeb 75DF at 2 to 3 lb. per acre, Dithane F45 at 1.2 to 2.4 qt. per acre, Manex at 1.2 to 1.6 qt. per acre, or Maneb 75DF or 80WP at 1 to 2 lb. per acre.	Apply fungicides on a 7-14 day schedule. 5 day PHI for mancozeb fungicides.
	OR	
	Quadris 2.08SC at 11.0 to 15.4 fl. oz. per acre.	Do not apply Quadris more than one time before alternating with a fungicide with a different mode of action. 7 to 14 day application schedule. 4 hour REI. 1 day PHI.
Virus diseases	Apply insecticides for aphid and cucumber beetle control since viruses are transmitted by these insects. Insect control will not be effective in reducing virus incidence in late-season curcurbits.	Several virus diseases, including cucumber mosaic virus, watermelon mosaic virus, squash mosaic virus, and zucchini yellow mosaic virus, can occur in the Midwest. Squash mosaic virus is seed transmitted. Inspect seedlings and discard those with virus-like symptoms. Obtain seed from reliable sources.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Alanap 2L	6 to 8 qt. per acre. Use lower rate on light-colored sandy soils (less than 1% organic matter).	Normally tank mixed with Prefar. A second broadcast application of Alanap made just before plants vine will give some control of small broadleaves. Not recommended for early spring use due to potential for crop injury.
Prefar 4E	5 qt. per acre on light-colored sandy soils, 6 qt. on other soils.	Apply before seeding or transplanting and incorporate lightly.
Curbit 3EC	3 to 4 pt. per acre.	**Direct seeded:** Use low rate on light soil. Apply to soil surface within 2 days after seeding. Do not incorporate. Needs 1/2 in. water within 5 days to activate. If no rain occurs, cultivate shallowly. **Transplants:** Apply as a banded spray to soil between rows of plastic mulch. **Do not** apply over or under hot caps, row covers, or plastic mulch. **Do not** broadcast over top of plants.
Dacthal 75WP	8 lb. per acre on light-colored soils (less than 1.5% organic), 14 lb. on darker colored soils in at least 50 gal. water.	**Direct seeded crop:** Apply to soil (no emerged weeds) after plants have 4 to 5 true leaves. Apply to moist soil or irrigate lightly after application to improve weed control. May be applied between rows of plastic mulch.
Command 3ME	0.67 pt. per acre, up to 1 pt. for cucumbers.	Apply prior to seeding or transplanting, or after seeding before crop emerges.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grasses. Maximum of 3 pt. per acre per season. 14 day PHI.
Select 2EC	6 to 8 fl. oz. for annual grasses; 8 fl. oz. for perennial grasses; plus 1 qt. COC per 25 gal. spray solution (1% v/v).	Apply to actively growing grasses. Wait at least 14 days between applications. Maximum 32 fl. oz. per seeason. 14 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before seeding or transplanting or after seeding but before crop emergence. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds at least 3 days before planting the crop. These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Seed corn maggots and cucumber beetles in seed beds	Treat seeds with a combination fungicide-insecticide, sucha s captan-lindane, at 1 oz. per 25 lb. of seed. AND Spray emerging seedlings with a mixture of 3 tablespoons methoxychlor 50WP per 2 gal. of water *plus* an approved fungicide at a rate of 2 gal. of water.	Early clean plowing of cover crops will generally result in less damage to seedling plants in the field. This is enough spray to treat one 10-sash bed, or about 400 sq. ft. Do not expect a fumigant used on the soil-manure mixture before seeding to protect seedling plants because flies can continue to lay eggs after plant emergence. Use low pressure when spraying to avoid seedling injury.
Cucumber beetles	Admire 2F at 16 to 24 fl. oz. per acre.	Apply pre-plant in a 2 inch or smaller band, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 24 fl. oz. per acre per season. 21 day PHI.
	Furadan 4F at 2.5 fl. oz. per 1000 linear feet of row.	Apply directly into seed furrow or as a 7-inch band over the row. This application is for seedling protection and beetle control after seedlings emerge or as transplants become established. **Indiana and Illinois only.**

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cucumber beetles and other insects listed on the labels	Monitoring.	Fields should be monitored frequently (2-3 times per week) to detect mass emergence of beetles in the spring. Insecticide applications should be focused on periods of heavy beetle activity. Evening sprays will reduce bee kill.
Thresholds **Cantaloupe and Cucumber - 1 beetle/plant** **Watermelon - 5 beetles/plant**	*Apply throughout the season when beetles exceed threshold.*	If Furadan 4F was applied just before or during transplanting, plants will need one spray to protect plants until plant uptake of Furadan has occurred.
	Adios at 0.5 to 0.75 lb. per acre. OR	Apply when beetle populations reach economic thresholds. 0 day PHI.
	Pounce 3.2EC at 4 to 8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre. OR	Apply a minimum of 4 gal. finished spray per acre by air or 20 gal. finished spray per acre with ground equipment. 0 day PHI.
	Ambush 2EC at 6.4 to 12.8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre. OR	Apply with ground equipment, using sufficient water to obtain full coverage of foliage. Do not apply more than 1.6 lb. a.i. per acre per season. 0 day PHI.
	Capture 2EC at 2.6 to 6.4 fl. oz. per acre per season. OR	Do not exceed 19.2 fl. oz. per acre per season. 3 day PHI.
	Asana XL at 5.8 to 9.6 fl. oz. per acre. OR	0.25 lb. a.i. per acre per season. 3 day PHI.
	Provado 1.6F at 3.75 fl. oz. per acre. OR	Do not exceed 18.75 fl. oz. per acre per season. Allow at least 5 days between applications. 0 day PHI.
	Sevin 50 WP at 2 lb., or 80SP at 1.25 lb., or XLR Plus at 1 qt. per acre. OR	Some phytotoxicity may result when carbaryl is applied during hot humid weather, especially on seedlings and newly set plants. Carbaryl may be highly toxic to bees visiting plants during bloom. 3 day PHI.
	Methoxychlor 2EC at 2 to 6 qt. pr acre. OR	Relatively non-toxic to bees. 7 day PHI.
	Thiodan, Endosulfan, or Phaser 50WP at 2 lb., or 3EC at 1 qt. per acre. OR	Do not exceed 6 applications or 3 lb. a.i. per acre per season. 2 day PHI.
	Diazinon AG500 at 1 pt. or 50WP at 1 lb. per acre.	3 day PHI for melons, 7 day PHI for cucumbers.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids	Conserve natural enemies.	Limiting the use of insecticides will conserve predators and parasites that help keep aphid populations under control.
	Monitoring.	Look for the presence of predators or parasitized aphids. Several predators per aphid colony will probably bring the aphid population under control without insecticide. Virus diseases carried by aphids **cannot** be prevented by killing aphids with insecticides.
	Admire 2F at 16 to 24 fl. oz. per acre. OR	Apply pre-plant in a 2 inch or smaller band, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 24 fl. oz. per acre per season. 21 day PHI.
	Thiodan, Endosulfan, or Phaser 50WP at 1 to 2 lb. or 3EC at 0.6 to 1.3 qt. per acre. OR	2 day PHI.
	Dimethoate at 1.5 pt. per acre. OR	**Do not use on cucumbers.** 3 day PHI.
	Capture 2EC at 2.6 to 6.4 fl. oz. per acre per season. OR	Do not exceed 19.2 fl. oz. per acre per season. 3 day PHI.
	Fulfill 50WG at 2.75 oz. per acre. OR	Do not exceed 5.5 oz. per acre per season. 14 day PHI.
	M-Pede at 1 to 2% by volume. OR	Must contact aphids to be effective. 0 day PHI.
	Metasystox-R 2SC at 2 pt. per acre. OR	14 day PHI for muskmelon, 7 day PHI for watermelons, and 3 day PHI for cucumbers.
	Actara 25 WDG at 2-3 oz. per acre.	Do not exceed 8.0 oz. per acre per season. 0 day PHI.
Mites	Kelthane 35WP at 1 to 1.6 lb. per acre. OR	2 day PHI.
	Dimethoate at 1.5 pt. per acre. OR	**Do not use on cucumbers.** 3 day PHI.
	Agri-mek 0.15EC at 8 to 16 fl. oz. per acre. OR	Do not exceed 48 fl. oz. per acre per season. Allow at least 7 days between applications. Do not make more than two sequential applications. 7 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Mites (cont.)	Capture 2EC at 5.2 to 6.4 fl. oz. per acre. OR	Do not exceed 19.2 fl. oz. per acre per season. 3 day PHI.
	Danitol 2.4EC at 10 2/3 fl. oz. per acre.	Do not exceed 42 2/3 fl. oz. per acre per season. 7 day PHI.
Whiteflies	Admire 2F at 16 to 24 fl. oz. per acre. OR Platinum 2SC at 5 to 8 fl. oz. per acre.	Apply pre-plant in a 2 inch or smaller band, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 24 fl. oz. Admire or 8.0 fl. oz. Platinum acre per season. 21 day PHI for Admire. 30 day PHI for Platinum.
	Capture 2EC at 5.2 to 6.4 fl. oz. per acre. OR	Do not exceed 19.2 fl. oz. per acre per season. 3 day PHI.
	Align or Neemix according to label directions. OR	0 day PHI.
	M-Pede at 1.25 fl. oz. pr 50 gal. water. OR	Must contact whiteflies to be effective. 0 day PHI.
	Actara 25WDG at 3 to 4 oz. per acre.	Do not exceed 8.0 oz. per acre per season. 0 day PHI.

Eggplant

Variety	Season	Comments
Dusky	Extra-early	Good but low yielding because of small fruit size
Classic	Early	Long, slim, tapered
Epic	Early	Oval
Ichiban	Early	Long, slender, "oriental" type
Kiko	Early Main	Holds color in fall
Caspar	Main	White, cylindrical
Rosita	Main	Lavender, long, cylindrical

Fertilizing

Lime: To maintain a soil pH of 6.0 to 6.8.

Preplant: N, 60 lb. per acre if soil organic matter less than 3%, 40 lb. per acre if soil organic matter greater than 3% or if following soybeans; P_2O_5, 0 to 200 lb. per acre; K_2O, 0 to 200 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. Set each plant with 1 cup (8 oz.) of starter solution. See p. 3 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.

Sidedress N: Apply 40 to 60 lb. N per acre to either side of the row when flowers appear. If using the plastic mulch system, the sidedressing can be eliminated because the mulch reduces leaching losses of N and increases early uptake of N, P, and K. If following soybeans or a legume sod, the sidedressing is not needed if rainfall is normal.

Spacing

Rows: 3 to 5 ft. apart. Plants: 2 to 3 ft. apart in a row.

Growing Transplants and Transplanting

The best transplants are fairly large, slightly hardened, 8 to 10 wks. old plants grown in 2 in. or larger pots. Optimum temperatures for growing the plants in the greenhouse are 70 to 75°F. A few days at 60 to 65°F are sufficient for hardening. Set plants in the field when frost danger has passed, when the soil has warmed, and when the average daily temperature reaches 65°F.

Eggplants are very responsive to the use of plastic mulches in the Midwest. Black plastic is recommended because no herbicides are available for use with clear plastic. Clear plastic is preferred for earliness and could be tried with soil fumigation (see Soil Treatment for Disease and Nematode Control, page 43); however, some weeds will tend to grow under clear plastic when heavier soils are fumigated.

Diseases Controlled	Treatment	Comments
Verticillium wilt	Avoid fields with a history of Verticillium wilt. Rotate with small grains where possible.	Use of long rotations out of solanaceous crops will prevent rapid increase of pathogen populations.
	Fumigate with Vapam (60 gal. per acre) under plastic mulch.	Allow at least 30 days between application of fumigant and transplanting.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. per acre on light-colored soils (less than 1.5% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply 4-6 wks. after transplanting. Can be sprayed directly over the transplants. Cultivate and remove all weeds before making application.
Devrinol 50DF	2 lb. per acre on light soil (less than 2% organic matter) and 4 lb. per acre on other soils.	Apply before transplanting. Incorporate 1 to 2 in. prior to planting succeeding crops, a deep moldboard or disc plowing must be done. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months.
Prefar 4E	5 qt. per acre on light-colored sandy soils (less than 1% organic matter), 6 qt. on other soils.	Apply before planting and incorporate 1-2 inches.
Trifluralin (4 lb./gal.)	1 to 1.5 pt. per acre.	Apply and incorporate before transplanting, or apply directed spray between rows after transplanting and incorporate. Marginal crop tolerance.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 4.5 pt. per acre per season. 20 day PHI.
Gramoxone Extra 2.5E	1.5 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. non-ionic surfactant per 25 gal. spray solution.	DIRECTED SPRAY ONLY. Apply to emerged weeds between crop rows. Do not allow spray to drift onto crop.
Select 2EC	6 to 8 fl. oz. for annual grasses; 8 fl. oz. for perennial grasses; plus 1 qt. COC per 25 gal. spray solution (1% v/v).	Apply to actively growing grasses. Wait at least 14 days between applications. Maximum 32 fl. oz. per season. 20 day PHI.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before transplanting. RUP.
Glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before planting the crop. Wait 3 days before planting.These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea Beetles **Thresholds** <3 inches - 2/plant 3-6 inches - 4/plant >6 inches - 8/plant	Sevin 50WP at 2 lb., 80SP at 1.25 lb., or XLR Plus at 1 qt. per acre.	3 day PHI.
	OR	
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 7 day PHI.
	OR	
	Ambush 2EC at 6.4 to 12.8 fl. oz., or 25 WP at 6.4 to 12.8 oz. per acre.	Do not exceed 2 lb. a.i. per acre per season. 3 day PHI.
	OR	
	Pounce 3.2EC at 4 to 8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre.	Do not exceed 2 lb. a.i. per acre per season. 3 day PHI.
	OR	
	Methoxychlor 2 EC at 1 to 3 pts. per acre.	7 day PHI. 1 day PHI if 1 pt. rate is used.
	OR	
	Actara 25WDG at 2 to 3 oz. per acre.	Do not exceed 8 oz. per acre per season. 0 day PHI.
Colorado potato beetle, European corn borer	Crop Rotation.	**For Colorado potato beetle only.** Plant as far as possible from last year's potato or eggplant fields to reduce damage.
	Scouting.	Regular (weekly) scouting will allow you to determine the need for and improve timing of insecticides.
Thresholds - Colorado Potato Beetles <6 inches - 2 small larvae or 1 large larva or 1 adult per plant >6 inches - 4 small larvae or 2 large larvae or 2 adults per plant	Provado 1.6F at 3.75 fl. oz. per acre.	Do not exceed 18.75 fl. oz. per acre per season. Allow 5 days between applications. 0 day PHI.
	OR	
	Admire 2F at 16 to 32 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. of Admire or Provado per acre per season. 21 day PHI for soil application.
	OR	
	Platinum 2SC at 5 to 8 fl. oz. per acre.	Do not exceed 8.0 fl. oz. per acre per season. 30 day PHI.
	OR	
	SpinTor 2 SC at 2.25 to 8 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not apply more than 0.35 lb. a.i. per acre per season. 7 day PHI.
	OR	
	Ambush 2EC at 6.4 to 12.8 fl. oz., or 25 WP at 6.4 to 12.8 oz. per acre.	Do not exceed 2 lb. a.i. per acre per season. 3 day PHI.
	OR	
	Pounce 3.2EC at 4 to 8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre.	Do not exceed 2 lb. a.i. per acre per season. 3 day PHI.
	OR	

INSECTS CONTROLLED	TREATMENT	COMMENTS
Colorado potato beetle, European corn borer (cont.)	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 7 day PHI.
	OR	
	Thiodan 50WP at 1 lb. or 3EC at 0.67 to 1.3 qt. per acre.	Should also control aphids. Do not apply more than 1 lb. a.i. per acre per season. 1 day PHI.
	OR	
	M-Trak at 1.5 to 4.0 qt. per acre, or Novodor at 1.0 to 4.0 qt. per acre.	*Bacillus thuringiensis* based insecticides. **Colorado potato beetles only.** Only controls small larvae. 0 day PHI.
	OR	
	Actara 25WDG at 2 to 3 oz. per acre.	Do not exceed 8 oz. per acre per season. 0 day PHI. **Colorado potato beetles only.**
Aphids	Conserve natural enemies.	Limiting the use of some insecticides will conserve predators and parasites that help control aphid populations.
	Provado 1.6F at 3.75 fl. oz. per acre.	Do not apply more than 18.75 fl. oz. per acre per season. Allow 5 days between applications. 0 day PHI.
	OR	
	Metasystox-R at 2 pt. per acre.	Do not apply more than 3 times per season. Should also control mites. 7 day PHI.
	OR	
	M-Pede at 1 to 2% by volume.	Must contact aphids to be effective. 0 day PHI.
	OR	
	Lannate LV at 1 to 3 pt. per acre, or Lannate 90SP at 0.5 to 1 lb. per acre.	5 day PHI.
	OR	
	Malathion according to label directions.	3 day PHI.
	OR	
	Thiodan 3EC at 1.33 qt. per acre.	1 day PHI.
	OR	
	Actara 25 WDG at 2 to 3 oz. per acre.	Do not exceed 8 oz. per acre per season. 0 day PHI.

Mint (Peppermint and Spearmint)

Varieties

Peppermint: Black Mitcham, Robert's Mitcham, Todd's Mitcham, and Murray Mitcham. The latter three varieties are more resistant to Verticillium wilt.

Spearmint: Scotch spearmint and Native spearmint. These two spearmints have distinctly different oils.

Planting and Rotation

The mints are grown from dormant runners (stolons) dug from existing fields in the last fall or spring. Because Verticillium wilt is an important disease problem, even with resistant varieties, growers should use disease-free stock. Certified planting stock is available. Also, careful fall plowing of established stands is important for winter protection and to reduce the incidence of mint rust and other foliar diseases. Squirrely mint has been recently found to be caused by a mite. No chemical control is registered for use at this time.

Although the mints are perennial, stands should not be maintained longer than 3 or 4 years in a rotation program. Older stands may show a serious build-up of disease, insect, and weed problems.

Irrigation has been shown to significantly increase essential oil yields both on muck and sandy soils. Significant yield increases of 20 to 50% have been obtained even in seasons with above average rainfall.

Fertilizing

Established mint - apply from 120 to 150 lb. N in split application (before emergence and before canopy closure). Potash and phosphorous should be maintained at 400 lb. K_2O and 50 lb. P_2O_5, respectively.

DISEASES Controlled	Treatment	Comments
Spearmint rust, Septoria leafspot	Bravo 500 at 2 pt. per acre; Bravo Ultrex at 1.25 lb. per acre; Bravo WS at 13/8 pt. per acre; Agronil and Echo 720 at 13/8 pt. per acre. Equus 720 at 1.37 pts. per acre.	**Indiana only.** Bravo, Terranil, or Echo at 2 to 3 pt. per acre. Rally 40W at 0.3125 lb. per acre. Repeat spray at 7-10 day intervals for a total of 3 sprays.
	OR	
	Rally 40W at 0.3125 lb. per acre.	Spray when disease symptoms first appear. Repeat at 14 to 21 day intervals. 30 day PHI.
Verticillium wilt	Use wilt-resistant varieties of peppermint (Todd's Mitcham, Murray Mitcham, or Robert's Mitcham). Native spearmint is resistant.	Rotate plantings after no more than 3 or 4 years.

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Sinbar 80WP	1 to 2 lb. per acre before mint emerges or apply 0.25 to 0.5 lb. per acre plus surfactant or crop oil postemergence to the crop and small weeds.	Do not exceed 2 lb. total per acre per season. Do not apply within 60 days of harvest.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE (cont.)		
Goal 2XL -- MUCK SOILS ONLY	2 to 3 qt. in 20 to 40 gal. of water per acre. Add a nonionic surfactant at 1 qt. per 100 gal. spray solution when applied postemergence to the weeds.	Apply only to dormant spearmint and peppermint grown on muck soil (greater than 20% organic matter). Do not apply to spearmint or peppermint grown on mineral or black sand soils. Application to emerged spearmint or peppermint will result in severe injury. Apply Goal before weeds are 4 in. tall. **Indiana only**.
Trifluralin (4 lb./gal.)	1 to 1.5 pt. per acre. Use lower rate on coarse soil and higher rate on fine soil. Incorporate or irrigate with 1/2 inch water.	Apply late winter to spring or in the fall after the harvest, when mint is dormant or semi-dormant.
Gramoxone 2.5E	24 to 38 fl. oz. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution. Apply before crop begins to grow in spring.	
POSTEMERGENCE		
Assure II 0.88E	8 to 10 oz. per acre.	Include 1 qt. COC or 1 pt. non-ionic surfactant per acre. Maximum application of 20 oz. per acre per season. 30 day PHI.
Basagran 4E	1 to 2 qt. per acre post-emergence to mint and weeds.	For yellow nutsedge and Canada thistle, repeat application 7-10 days later. A crop oil will enhance activity. Do not apply more than 4 pt. per acre per season.
Buctril 2E	1 to 1.5 pt. per acre in at least 10 gal. water per acre. Apply before weeds have more than 4 to 6 leaves. Do not apply when air temperatures exceed or are expected to exceed 70°F within 5 days of application.	Application should only be made on established mint that has been harvested at least one year prior to application. Buctril may cause temporary stunting and leaf chlorosis when applied to growing mint. Do not apply to mint growing under stressful conditions. Check label precautions. 70 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE (cont.)		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC or 1 pt. Dash HC per acre.	Apply to actively growing grass. Do not apply more than twice per season. 20 day PHI.
Stinger 3EC	0.33 pt. per acre for annual weeds to 0.5 pt. per acre for perennial weeds, plus 1 pt. nonionic surfactant per 100 gallons spray solution. Use a total of 10 gals. or more total volume per acre.	Apply after mint and weeds have emerged. For Canada thistle control, apply prior to bud stage of the weed. Do not apply more than 1 pt. per acre per season, and do not apply by air. 45 days PHI.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cutworms, loopers	Lannate 90SP at 1 lb. or LV at 2 1/4 to 3 pt. per acre.	14 day PHI.
	OR	
	Orthene/Address 75S at 1.3 lb. per acre.	Do not apply more than 2.6 lb. per year. 14 day PHI.
	OR	
	Lorsban 4E at 2 to 4 pt. per acre.	Use lower rate when cutworm larvae are less than 3/4 inch long. Only 1 application per growing season. 90 day PHI.
	OR	
	Bacillus thuringiensis. (MVP, Javelin, Dipel, Lepinox, Biobit, Agree, Ketch, etc.) Follow label rates.	0 day PHI.
Flea beetle	Malathion 57EC at 1.5 pt. per acre.	For best results, apply immediately after harvest on stubble. 7 day PHI.
	OR	
	Lannate 90SP at 1 lb. or 2.4LV at 3 pt. per acre.	For best results, apply immediately after harvest on stubble. 14 day PHI.
Mites	Metasystox-R at 3 pt. per acre. Repeat treatment in 10-14 days.	Ground application only. Apply in at least 20 gal. of water. 14 day PHI.
	OR	
	Omite 6E at 2 to 3 pt. per acre.	No more than 2 applications per year. 14 day PHI.

Onion (Dry Bulb and Green Bunching)

Varieties

Bulb — sEarly: Norstar, Cavalier, Comanche.
Main: Copra, Burgos, Lakota, Nitro, Spirit.
Late: Celtic, Sweet Sandwich, Spartan Banner 80, Crusader.
Green — Beltsville Bunching.

Spacing and Seeding

Raised beds with two double rows or wide rows spaced 14 in. apart on top of the bed with 12 seeds per foot within the wide (2 in.) row. Seed: 4 lb per acre.

Or transplant 4 in. apart in rows.

Fertilizing

Lime: Mineral soils: To maintain a soil pH of 6.0 to 6.8. Organic soils: Lime if the pH is less than 5.2.

Preplant: N for mineral soils, 70 lb. per acre with 1/2 broadcast preplant and 1/2 applied as a band 2 in. below the seed; N for organic soils: 100 lb. per acre broadcast and disked in; P_2O_5, 25 to 250 lb. per acre; K_2O, 0 to 250 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. At seeding, spray directly on the seed a solution of 2-6-0 at 1 pint per 100 ft. of linear row. A 2-6-0 solution is equivalent to a 1:5 dilution of 10-34-0 liquid fertilizer with water. On muck soils with a pH greater than 6.0, add 1 lb. of $MnSO_4$ per 1000 ft. of row at seeding, or use foliar Mn at the rate of 0.3 lb./100 gallons. Apply 2 to 3 times during the season starting 3 weeks after emergence.

Sidedress N: Mineral soils: 60 lb. N per acre to either side of the row at the four to five -week stage of growth or by June 1. Muck soils: No sidedress N needed unless heavy rain occurs.

Diseases Controlled	Treatment	Comments
Alternaria purple blotch and Botrytis leaf blight Dry bulb	3-4 year crop rotation.	Rotation out of onions or related vegetables will reduce the threat of these diseases in future onion crops.
	Apply fungicides beginning when disease first appears.	
	Rovral 4 F at 1.0 to 1.5 pt. per acre. Rovral WG at 1.0 lb. per acre. 14 day spray interval.	Use low rate when tank mixed with another product registered for use on onion. 7 day PHI.
	OR	
	Bravo 500 at 1.5 to 3 pt. per acre, Bravo Weather Stik or Agronil 720 at 1 to 2 pt. per acre, Equus DF at 0.9 to 2.7 lb. per acre, Bravo Ultrex at 0.9 to 1.8 lb. per acre (dry bulb), Terranil Cu at 2.25 to 4.5 pt. per acre, or Echo at 2 to 3 pt. per acre for flowable (F) formulations or 1.5 to 2.5 lb. per acre for dry (DF, DG) formulations.	Do not use Bravo on Spanish onions. Avoid more than 4 applications of chlorothanil products per season. Alternate with other registered products. 7 day PHI.
	OR	

DISEASES CONTROLLED	TREATMENT	COMMENTS
Alternaria purple blotch and Botrytis leaf blight		
Dry bulb (cont.)	Dithane DF at 3 lb. per acre or Dithane F-45 2.4 pt. per acre, Maneb 80 at 2 to 3 lb. per acre, Manex at 1.6 to 2.4 qt. per acre.	7 day PHI.
	OR	
	Apply Switch 62.5WG at 11-14 oz. per acre.	Use 7 to 10 day interval. May be effective when used in rotation with other pesticides labeled for purple blotch or botrytis leaf blight. 7 day PHI.
	OR	
	Quadris 2.08 SC at 6.2 to 12.3 fl. oz. per acre. **Purple Blotch and rust only.**	Do not apply more than 3 sequential applications of Quadris before alternating with a fungicide with a different mode of action. 4 hour REI. 0 day PHI.
	OR	
Green bunching	Aliette at 2 to 3 lb. per acre.	12 hour REI. 3 day PHI.
	Bravo 500 at 2 to 4.25 pt. per acre, Bravo Weather Stik or Agronil 720 at 1.5 to 3 pt., Equus at 1.4 to 2.7 lb. per acre, Echo at 1.5 to 3 pt. per acre, Terranil Cu at 3.4 to 6.75 pt. per acre.	**Do not use Bravo on Spanish Onions.** Avoid more than 4 applications of chlorothanil products per season. Alternate with other registered products. 14 day PHI.
	OR	
	Maneb 80 at 2 to 3 lb. per acre, Manex at 1.6 to 2.4 qt. per acre.	7 day PHI.
	OR	
	Apply Switch 62.5 WG at 11-14 oz. per acre.	Use 7 to 10 day interval. May be effective when used in rotation with other pesticides labeled for purple blotch or botrytis leaf blight. 7 day PHI.
	OR	
	Quadris 2.08 SC at 6.2 to 12.3 fl. oz. per acre. **Purple blotch and rust only.**	Do not apply more than 3 sequential applications of Quadris before alternating with a fungicide with a different mode of action. 4 hour REI, 0 day PHI.
Downy mildew Dry bulb	Ridomil Gold MZ at 2.5 lb. per acre. 14 day spray interval.	7 day PHI. 48 hour REI.
	OR	

DISEASES CONTROLLED	TREATMENT	COMMENTS
Downy mildew Dry bulb (cont.)	Dithane, Manzate, Maneb, Penncozeb, Manex ro Manex II at 2.4 qt. per acre for flowable (F) formulations or 2-3 lb. per acre for dry (WP, DF, DG) formulations.	24 hour REI. 7 day PHI.
	OR	
	Ridomil Gold Bravo at 2.0 lb. per acre. 14 day spray interval.	48 hour REI. 7 day PHI.
	OR	
	Aliette at 2 to 3 lb. per acre	12 hour REI. 3 day PHI.
	OR	
	Quadris Flowable at 9.2 to 15.4 fl. oz. per acre. Note higher rate carefully.	Do not make more than 1 sequential application of Quadris before alternating with fungicides with a different mode of action. 4 hour REI. 0 day PHI.
Green bunching	Bravo Weather Stik at 1 1/3 to 3 pt. per acre. Bravo 500 at 2 to 4.25 pt. per acre. Echo 720 at 1.5 to 3 pt. per acre.	48 hour REI. 14 day PHI.
	OR	
	Maneb 80 at 2-3 lb. per acre, Manex at 1.6 to 3.4 qt. per acre.	24 hour REI. 7 day PHI.
	OR	
	Ridomil Gold Bravo at 2.0 lb. per acre. 14 day spray interval.	48 hour REI. 7 day PHI.
	OR	
	Quadris Flowable at 9.2 to 15.4 fl. oz. per acre. Note higher rate carefully.	Do not make more than 1 sequential application of Quadris before alternating with fungicides with a different mode of action. 4 hour REI. 0 day PHI.
Fusarium basal rot	Use Fusarium-resistant varities such as Elba Globe, Spartan Banner and Harvestmore.	Consult seed catalogues for varietal characteristics.
Neck rot	Windrow plants until neck tissues are dry before topping and storage. Cure rapidly and properly.	Artificial drying may be necessary (forced heated air at 93-95°F for 5 days).

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	6 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply immediately after seeding or transplanting, or after a clean cultivation and hand weeding. Use 50-mesh or larger screens. Not effective on muck soil. Can be used up to 14 weeks after planting.
oxyfluorfen 2L or 1.6E	1 to 2 pt. per acre of 2L or 1.25 to 2.5 pt. per acre of 1.6E in a minimum of 20 gal. water. Use lower rate on coarse textured soils.	**Transplants only.** Apply after soil preparation and before transplanting. Do not use before direct-seeding onions. **Dry bulb onions only.**
Prowl 3.3 EC Pendimax 3.3E	0.6 to 2.4 qt. per acre.	**Seeded or bulbs** *Muck soil:* Apply 2 to 2.4 qt. per acre preemergence and after the 2 leaf stage. A third application can be made at the 6-9 leaf stage. Pack soil well over the row. Maximum application of 7.2 qt. per acre per year. *Mineral soils:* Apply 1.2 to 3.6 pt. per acre when onions have 2 to 9 leaves. Maximum application of 3.6 pt. per acre per year. 45 day PHI. **Transplants** Apply after transplanting. *Muck soil:* 2 or 3 applications at 2 to 2.4 qt. per acre. *Mineral soil:* 1 or 2 applications at 1.2 to 3.6 pt. per acre. 45 day PHI.
Prefar 4E	5 qt. per acre on light-colored sandy soils (less than 1% organic matter), 6 qt. on other soils.	**Dry bulb only.** Apply before planting and incorporate 1-2 inches, or apply after seeding and before crop emerges, and irrigate within 24 hours. **Mineral soils only.**
Trifluralin	0.75 to 1.25 pt. per acre. Use lower rate on coarse soil and higher rate on medium textured soils. Incorporate within 1 day of application.	**Dry bulb only.** Apply as a directed spray between rows. Do not allow spray to contact bulbs or tops. May result in delayed or lower yields if crop is stressed. Mineral soils only. 60 day PHI.
Dual Magnum	0.67 to 1.33 pt. per acre.	Apply to the 2 true leaf stage of onions. Southern Minnesota only. Can cause severe injury. Damage waiver required. 60 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE		
oxyfluorfen 2L or 1.6E	8 fl. oz. per acre of 2L or 9.6 fl. oz. of 1.6E in 40 to 60 gal. water per acre.	Apply to direct-seeded onions after they have 2 true leaves. Up to 2 pt. per acre of 2L or 2.5 pt. of 1.6E may be applied over transplanted onions within 2 days of transplanting. Spray during sunny warm weather. Do not exceed 2 pt. per acre of 2L or 2.5 pt. of 1.6E per season (including applications before transplanting). **Dry bulb only.** 45 day PHI.
Buctril 2E	1 to 1.3 pt. per acre in 50 to 70 gal. water per acre if applied to emerged onions. Do not use surfactant.	Apply when onions have 2 to 5 true leaves. Apply when soil and leaves are dry to prevent crop injury. Thorough coverage necessary. On muck soils east of the Mississippi River only, may be applied 3-4 days before emergence.
Fusilade DX 2E	10 to 12 fl. oz. plus 1 pt. nonionic surfactant per acre.	Apply to small, actively growing grasses. **Dry bulb only.** 45 day PHI.
Poast 1.5E	1 to 1.5 pt. plus 1 qt. nonionic surfactant per acre.	Apply to actively growing grasses. Maximum of 4.5 pt. per acre per season. 30 day PHI.
Select 2EC	6 to 16 fl. oz. plus 1% COC per acre.	Apply to actively growing grasses. Will kill bluegrass. Do not apply more than 32 fl. oz. per acre per season. **Dry bulb only.** 45 day PHI.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre plus 1qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before or after seeding, but before crop emerges. 60 day PHI. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply before crop emerges. Rates are for annual weeds at 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Onion Maggots	For furrow treatment at planting:	
	Lorsban 4E at 1.1 fl. oz. per 1000 linear ft. of row as an in-furrow drench.	Use a minimum of 40 gal. of total drench per acre. One application per year.
	OR	
	Diazinon 14G at 7 lb. per acre as a furrow application.	May be used on dry or green onions.
	OR	
	Diazinon AG500 at 2 to 4 qt. per acre.	Planting-time treatment only. Apply in sufficient water to drench seed furrow planting.
Other recommended control procedures include: Remove cull onions after harvest; plant as far as possible from last year's onion fields; and avoid mechanical damage to onions (undamaged bulbs are more resistant to maggot damage).		
Onion thrips	Field site selection.	Onion thrips build to high levels in small grains and move to onions when small grains dry down or are harvested. Avoid planting next to small grains.
Threshold 25 thrips per plant	Resistant/tolerant varieties.	Tolerant varieties include White Keeper, El Charro, Snow White, Vega, X201, and Zapotec.
	Ammo 2.5EC at 4 to 5 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. per acre per season. 7 day PHI.
	OR	
	Warrior 1EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 1.92 pts. per acre per season. 14 day PHI.
	OR	
	Fury 1.5E or Mustange 1.5EW at 3.2 to 4.2 fl. oz. per acre.	**Dry bulb only.** 7 day PHI.
	OR	
	Diazinon AG500 at 1 pt. per acre.	Use 100 to 200 gal. of water per acre for improved control. 14 day PHI.
	OR	
	Guthion 2L at 2 to 3 pt. per acre.	Do not exceed three applications per season. Allow at least 7 days between applications for bulb onions, 10 days for green onions. 28 day PHI for dry bulbs, 14 days for green onions.
	OR	
	Ambush 2EC at 9.6 to 19.2 oz. or 25WP at 9.6 to 19.2 oz. per acre or Pounce 3.2EC at 6 to 12 oz. or 25 WP at 9.6 to 19.2 oz. per acre.	**Dry bulb only.** Use when thrips first appear. Not for rescue treatments. 1 day PHI.
	OR	
	Lannate LV at 3 pt. per acre or 90SP at 1 lb. per acre.	7 day PHI.
	OR	
	Penncap-M at 1 qt. per acre.	15 day PHI.

Pea And Cowpea

Pea Varieties	Season	Comments
Shell Peas		
Spring	Early	
Knight	Early	Short vines
Bolero	Mid	
Green Arrow	Mid to Late	Long holding in field
Lincoln	Mid to Late	Very sweet, home garden variety
Snap peas (edible-podded)		
Sugar Bon	Early	Short vines
Sugar Ann	Early	Short vines
Cascadia	Main	
Supersnappy	Main	Large pods
Snow peas (edible-podded)		
Oregon Giant	Mid to late	Large pods
Snowflake	Late	Dark green
Super Sugar Pod	Late	Long vines

Spacing and Seeding

Rows: 32 to 36 inches apart, 6 to 8 seeds per foot of row. Seed: 100 to 150 lb. per acre.

Fertilizing

Lime: To maintain a soil pH of 6.0 to 6.8.

Preplant: N, for soils with more than 3% organic matter and following soybeans, alfalfa or a grass-legume hay crop no N is needed. For soils with less than 3% organic matter and the above rotation apply 20 lb. N per acre. For peas following corn, rye, oats, wheat, or a vegetable crop apply 40 lb. N per acre. P_2O_5, 0 to 100 lb. per acre; K_2O, 0 to 100 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. Band at seeding 12-48-0 lb. (N-P_2O_5-K_2O) per acre in bands at least 2 in. below and 2 in. to the side of the row. Do not apply fertilizer with the seed because germinating pea seed is especially sensitive to fertilizer salt injury.

Sidedress N: None needed.

Diseases Controlled	Treatment	Comments
Ascochyta blight	Use pathogen-free seed. 3-year rotation.	
Fusarium wilt	Use resistant cultivars.	
Powdery mildew	Spray 8-10 lbs. wettable sulfur OR Dust 325-mesh dusting sulfur	Plant powdery mildew-resistant varieties. Begin application of sulfur at first sign of mildew. Do not apply dust sulfur when temperatures are above 85°F.
Root rot	Rotate fields with a history of root rot for at least 4 to 5 years.	Include a crop of oats (green manure or full season crop) the year before planting peas.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Seed rot and damping-off	Use pathogen-free seed. Treat seeds with Captan or Thiram.	Apply seed-treatment just before planting. Follow label directions.
Virus diseases	Use virus-free seed. Control aphids effectively.	Several viruses infect peas, which are spread by aphids.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Trifluralin (4 lb./gal.)	1 pt. per acre on light-colored soils (less than 2% organic matter), 1.5 pt. on darker colored soils.	Apply before planting, and incorporate into soil by double discing or with other equipment to give thorough mixing 3 to 4 in. deep. Not effective on high organic soils.
Dual Magnum, Dual II Magnum	1 to 2 pt. per acre.	Apply preemergence only. Do not incorporate.
Command 3ME	1.3 pt. per acre.	**Pea only.** Apply prior to seeding or after seeding before crop emerges.
Pursuit Plus	20 to 30 fl. oz. per acre.	**Pea only.** Apply before planting and incorporate. Use only in IL, IA, lower peninsula of MI, WI, MN south of highway #210. Apply before June 30. 30 day PHI.
Dacthal 75WP	8 lb. on light soils (less than 1.5% organic matter), 14 lb. on darker soils in at least 50 gal. water per acre.	Apply immediately after planting. Use 50-mesh or larger screens. Not effective on muck soils and other high organic soils. **Cowpea only.**
Prowl 3.3E, Pendimax	Prowl at 1.2 to 3.6 pt. per acre.	Apply preplant and incorporate 1 to 2 in. deep.
POSTEMERGENCE		
Assure II 0.88E	6 to 12 fl. oz. plus 1 qt. COC per acre.	Apply to actively growing grass. 30 day PHI.
Basagran 4L	0.75 to 1 qt. per acre.	Apply when weeds are small and after peas have 3 pairs of leaves. Do not add COC to peas. Do not apply more than 2 qt. per acre per season. 30 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT	COMMENTS
Poast 1.5E	1.0 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 4 pt. per acre per year. **Pea only.** 15 day PHI.
Thistrol 2EC	2 to 4 pt. per acre.	FOR CANADA THISTLE CONTROL. Apply when peas have developed 6 to 12 nodes and weeds are less than 3 in. tall. **Pea only.**
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply before or after planting, but before crop emerges. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply before or after planting, but before crop emerges. These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Seed corn maggot	Plant seed that has been treated with diazinon or a lindane-diazinon combination.	Adult flies are attracted to rotting organic matter or freshly plowed soil.
Caterpillars (including loopers, armyworms, cutworms, and alfalfa caterpillars)	Capture 2EC at 2.1 to 6.4 fl. oz. per acre per season.	Do not exceed 12.8 fl. oz. per acre per season. 3 day PHI.
	OR	
	Asana XL at 2.9 to 9.6 fl. oz. per acre.	For processing peas, treat 8-10 days before harvest. Do not exceed 0.1 lb. a.i. per acre per season. Do not feed treated vines to livestock. 3 day PHI, 21 day PHI for cowpeas.
Threshold 1 caterpillar per 25 sweeps and more than 10 days until harvest	OR	
	Lannate 90SP at 0.5 to 1 lb. per acre, or LV at 1 to 3 pts. per acre.	Do not feed treated vines to livestock for 14 days. 1 day PHI, 14 day PHI for cowpeas.
	OR	
	SpinTor 2SC 4-6 fl. oz. per acre.	3 day PHI. Do not exceed 24 fl. oz. per acre per season or 12 fl. oz. per acre per season for cowpeas.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids **Threshold** 25 aphids per sweep and more than 15 days until harvest	Capture 2EC at 2.1 to 6.4 fl. oz. per acre. OR	Do not exceed 12.8 fl. oz. per acre per season. 3 day PHI.
	Dimethoate at 0.5 pt. per acre on peas or 0.75 to 1.5 pt. per acre on cowpeas. OR	Do not feed treated vines to livestock. Do not exceed one application per season on peas. 0 day PHI.
	Diazinon 50W at 0.75 to 1.0 lb. per acre. OR	Vines may be fed to dairy and beef cattle and sheep. **Succulent peas only.** 7 day PHI.
	Lannate LV at 1 to 3 pts. per acre. OR	1 day PHI, 14 day PHI for cowpeas.
	Thiodan 50 WP at 2 lbs. per acre. OR	Do not make more than 3 applications per season. 3 day PHI for cowpeas, 5 day PHI for peas.
	Orthene/Address 75S at 0.6 to 1.3 lbs. per acre.	Apply when insects first appear. Repeat as necessary. Do not feed treated vines to livestock. **Cowpeas only.** 14 day PHI.
Armyworms, corn earworm, European corn borer (on cowpeas)	Sevin 80S at 1.25 lbs., or XLR Plus at 1 qt. per acre. OR	21 day PHI.
	Lannate LV at 1 to 3 pts. per acre. OR	14 day PHI.
	Thiodan 50WP at 2 lbs. per acre. OR	Do not exceed 3 applications per season. **Armyworm only.** 3 day PHI.
	Orthene/Address 75S at 1 to 1.3 lbs. per acre. OR	Apply when insects first appear. Repeat as necessary. Do not feed treated vines to livestock. 14 day PHI.
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. **Succulent peas only.** 3 day PHI.
Bean leaf beetle (on cowpeas)	Sevin 80S at 1.25 lbs. or XLR Plus at 1 qt. per acre. OR	21 day PHI.
	Orthene/Address 75S at 0.6 to 1.3 lbs. per acre. OR	Apply when insects first appear. 14 day PHI.
	Thiodan 50WP at 1 to 2 lbs. per acre. OR	Do not exceed 3 applications per season. 3 day PHI.
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. **Succulent peas only.** 3 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cowpea curculio, Pea weevil (on cowpeas)	Sevin 80S at 1.8 lbs. or XLR Plus at 1 qt. per acre.	21 day PHI.
	OR	
	Lannate LV at 1 to 3 pts. per acre.	14 day PHI.
	OR	
	Thiodan 50WP at 1 to 2 lbs. per acre.	For cowpea curculio, make 3 applications at 5-day interval starting when pods are 0.5 inch long. 3 day PHI.
	OR	
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. **Succulent peas only.** 3 day PHI.
Stink bugs (on cowpeas)	Sevin 80S at 1.25 lbs., or XLR Plus at 1 qt. per acre.	21 day PHI.
	OR	
	Lannate LV at 1 to 3 pts. per acre.	14 day PHI.
	OR	
	Thiodan 50WP at 1 to 2 lbs. per acre.	Do not exceed 3 applications per season. 3 day PHI.
Thrips (on cowpeas)	Lannate LV at 1 to 3 pts. per acre.	14 day PHI.
	OR	
	Orthene/Address 75S at 0.6 to 1.3 lbs. per acre.	Apply when insects first appear. Repeat at 7-10 day intervals as necessary. Do not feed treated vines to livestock. 14 day PHI.
	OR	
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. **Succulent peas only.** 3 day PHI.

Pepper

Varieties*	Season	Fruit Shape	Comments
Acapulco	Early	Blocky	Vigorous plant
Early Sunsation	Early	Blocky	Yellow at maturity
King Arthur	Early	3-4 lobes, blocky	Resistant to strain 2 of bacterial spot
Merlin	Early	Blocky	
Paladin	Early - Main	Long blocky	Tolerant to phytopthoptera
Sentinel	Early - Main	Blocky	Resistant to strains 1,2 of bacterial spot
Vidi	Early - Main	4 lobes, long	Good for red peppers
Boynton Bell	Main	Blocky	Resistant to strains 1,2,3 of bacterial spot
Commandant	Main	Long blocky	Resistant to strains 1,2,3 of bacterial spot
Bell King	Main	Long blocky	
Camelot X3R	Main	Long blocky	Resistant to strains 1,2,3 of bacterial spot
Enterprise	Main	Long blocky	
Lantern	Main	Long blocky	

Green Bells for trial: X3R Aladdin, X3R Wizard (both with some resistance to bacterial spot).
Colored Bells for trial: Gold Finch (yellow); Orange Grande, Oriole (orange); Sweet Chocolate, Blackbird (brown to black).
Banana peppers/cubanelles: Sweet Banana (turns red at maturity); Key Largo (cubanelle, orange-red at maturity).
Hot Peppers: Hungarian Hot Wax, Jalapeno Mitla, Long Thick Red, Ring of Fire, Copacabana (yellow).

Spacing

Rows 2 1/2 to 4 ft. apart. Plants 12 to 18 in. apart in row. Or plant in double/twin rows with 18 in. between row and 12 in. between plants. Raised beds, plastic mulch, and trickle irrigation recommended.

Growing Transplants and Transplanting

Fairly large, slightly hardened 6-9 week old plants are the best transplants. These should be grown in greenhouses having 75°F daytime temperatures. Germination is rapid between 65 to 85°F, very slow at 60°F, and ceases below 55°F. A few days at 60 to 65°F are sufficient for hardening before transplanting.

Transplants are often grown by seeding directly in plant-growing flats and thinning to about 4 sq. in. per plant when the first true leaf appears. Larger cell sizes (No. 50 or 72) work well to promote early yield, with smaller cell sizes (No. 100 or 120) recommended for plants to be grown for the remainder of the season. Direct-seeding in outdoor hotbeds or spotting seedlings in the plant growing flats also produces good transplants. Large-scale growers often use plants grown outdoors in southern states. An ounce of seed produces 1,500 to 2,000 good plants, and 4 oz. provides enough plants for an acre.

Set plants in the field when frost danger has passed, when the soil has warmed, and when the average daily temperature reaches 65°F. It does not pay to rush the season by planting too early. Raised beds and plastic mulch are recommended.

Fertilizing

Lime: To maintain a soil pH of 6.0 to 6.8.

Preplant: N, for soils with more than 3% organic matter and following soybeans, alfalfa or a grass-legume hay crop apply 50 lb. N per acre. For soils with less than 3% organic matter and the above rotation, apply 80 lb. N per acre. For peppers following corn, rye, oats, wheat, or a vegetable crop, apply 70 to 80 lb. N per acre. P_2O_5, 0 to 150 lb. per acre; K_2O, 0 to 200 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. For transplants, a starter solution at the rate of 1 cup (8 oz.) per plant is recommended. See p. 3 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.

Sidedress N: Apply 40-50 lb. N per acre in a band to either side of the row 3 to 4-weeks after transplanting. Urea or calcium nitrate is recommended. If plastic mulch is used, this sidedressing can be skipped. Peppers are susceptible to calcium deficiency even when adequate levels of calcium are present in the soil. This disorder is called blossom end rot. It often occurs under conditions of inadequate or excessive watering and/or excessive N fertilization with an ammonium source. Where the soil pH has been adjusted to 6.0 or above, additional soil applied calcium does not correct the disorder. Addition of a foliar spray directly to the developing fruit may reduce the incidence of blossom end rot. Use calcium nitrate at the rate of 10-15 lb. per 100 gallons of water per acre.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Anthracnose		Use disease-free seed and/or transplants. Practice a 3-4 year crop rotation.
	Apply Flint at 3 to 4 oz. per acre.	3 day PHI. Maximum 16 oz. and 4 applications per season. No more than 3 sequential applications of Flint or other strobulurin fungicide.
	Apply Maneb 80 (1.5 to 3 lb. per acre) or Manex (1.2 to 2.4 qt. per acre) at first sign of disease. Repeat at 7-10 day intervals.	24 hour REI. 7 day PHI.
Bacterial spot	Use resistant varieties wherever possible.	Use disease-free seed and/or transplants.
	In greenhouse apply Kocide DF at 2 to 3 TBSP, Kocide 2000 at 1.5 to 2.25 TBSP, or Kocide 101 at 4 to 6 TBSP per 1000 square feet. Champion WP at 4 to 6 TBSP per 1000 square feet.	24 hour REI. Repeat at 5 to 10 day intervals.
	OR	
	Agri-mycin 17 at 200 ppm.	Begin applications at the 2 leaf stage on a 4 to 5 day schedule until transplanted in the field. 12 hour REI.
	Use copper sprays to reduce the rate of bacterial spread in the field. The combination of a copper fungicide plus Maneb will increase the effectiveness of the application.	Avoid consecutive seasons with peppers or tomatoes in the same field. Avoid working in the fields when plants are wet.
Phytophthora blight	Avoid waterlogged root zones throughout the season.	Grow peppers in well drained fields. Planting on raised beds will increase soil drainage. Rotate infested fields with non-host crops for several years.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Phytophthora blight (cont.)	Use **resistant varieties** that are becoming available for commercial production. Check with seed sales representatives.	Water management is of primary importance for Phytophthora control.
	Treat soil with Ridomil Gold EC at 1 pt. per acre (broadcast; use less for band application) before transplanting. Subsequent directed sprays may be needed. OR Maneb 80 at 1.5 to 3 lb. per acre, or Manex at 1.2 to 2.4 qt. per acre at 7-10 day intervals.	Fungicides will not be effective if peppers are planted in poorly drained fields with a history of the disease. 48 hour REI. 0 day PHI. Spray on a 7 to 10 day schedule when disease threatens. 7 day PHI.
Blossom-end rot	Avoid drastic fluctuations in moisture. Mulching plants may help. Avoid excessive nitrogen or potassium fertilization, rapid plant growth and root pruning during cultivation. Maintain soil pH and calcium levels in desired range. Choose varieties that are less susceptible.	Blossom-end rot is caused by a calcium deficiency in the fruit, although calcium levels in the soil may be sufficient. Wide fluctuations in water levels in the soil can trigger the disorder.
Root-knot nematode	Methyl bromide or Sodium methyl dithiocarbamate or Vydate L.	Sample fields during growing season for plant parasitic nematodes before planting. Avoid fields with high numbers of root-knot nematode Methyl bromide and sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate gives adequate control when nematode populations are low to moderate.
Virus diseases	Grow resistant varieties. Plant disease-free transplants. Eliminate broadleaf weeds within 150 feet of field before crops are established.	Some broadleaf weeds may act as reservoirs for pepper viruses. Aphids may spread virus diseases from weeds to peppers and from diseased peppers to healthy peppers. Oil sprays timed with periods of aphid flight may prevent transmission of viruses by aphids but have short term residual effectiveness. Light-colored and reflective mulches may deter aphids from landing on plants and transmitting the virus.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	6 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker-colored soils in at least 50 gal. water per acre.	Apply 4-6 wks. after transplanting. Use 50-mesh or larger screens. Not effective on muck soils or other high organic soils.
Devrinol 50DF	2 lb. per acre on light-colored soils (less than 2% organic matter), 4 lb. on other soils.	Incorporate Devrinol 1 to 2 in. before seeding or transplanting. After harvest or prior to planting succeeding crops, a deep moldboard or disc plowing operation must be done. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months after using Devrinol.
Trifluralin (4 lb./gal.)	1 pt. per acre on light-colored soils (less than 2% organic matter), 2 pt. on darker soils.	Apply before transplanting and incorporate immediately.
Prefar 4E	5 qt. per acre on light-colored sandy soils (less than 1% organic matter), 6 qt. on other soils.	Apply before planting and incorporate 1-2 inches.
Command 3ME	0.67 to 2.67 pt. per acre.	Apply before transplanting. **Not for use on banana peppers.**
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 4.5 pt. per acre per season. 20 day PHI.
Gramoxone Extra 2.5E	1.5 pt. per acre plus 1 qt. COC or nonionic surfactant per 25 gal. spray solution.	DIRECTED SPRAY ONLY. Apply to emerged weeds between crop rows. Do not allow spray to drift onto crop.
Select 2EC	6 to 8 fl. oz. for annual grasses; 8 fl. oz. for perennial grasses; plus 1 qt. COC per 25 gal. spray solution (1% v/v).	Apply to actively growing grasses. Wait at least 14 days between applications. Maximum 32 fl. oz. per season. 20 day PHI.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before transplanting crop. RUP.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
NON-SELECTIVE HERBICIDES (cont.)		
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before planting crop. Wait 3 days before planting. These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
European corn borer and flea beetles Threshold Treat at 5-day intervals when peppers are fruiting if blacklight trap catches exceed 5 to 10 moths per night.	Orthene 75S at 1 to 1.33 lb. per acre.	Also controls aphids. 7 day PHI.
	OR	
	Ambush 2EC at 6.4 to 12.8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre, or Pounce 3.2EC at 4 to 8 fl. oz. per acre.	**Bell peppers only.** Do not exceed 1.6 lb. a.i. per acre per season. Use higher rate for European corn borer. 3 day PHI.
	OR	
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 7 day PHI.
	OR	
	SpinTor 2 SC at 4 to 8 fl. oz. per acre.	**European corn borers only.** Do not exceed 29 fl. oz. per acre per season. 1 day PHI.
	OR	
	Admire 2F at 16 to 32 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. of Admire or Provado per acre per season. **Flea beetles only.** 21 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	**Flea beetles only.** Do not exceed 0.35 lb. a.i. per acre per season. 7 day PHI.
	OR	
	Actara 25WDG at 2 to 3 oz. per acre	**Flea beetles only.** Do not exceed 8 oz. per acre per season. 0 day PHI.
	Capture 2SC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 7 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids	Conserve natural enemies.	Limiting the use of insecticides will conserve predators and parasites that will help keep aphid populations under control.
	Platinum 2SC at 5 to 8 fl. oz. per acre. OR	Do not exceed 8.0 fl. oz. per acre per season. 30 day PHI.
Aphid-transmitted viruses cannot be controlled by killing aphids with insecticides.	Admire 2F at 16 to 32 fl. oz. per acre. OR	Do not exceed 0.5 lb. a. i. or Admire or Provado per acre per season. Will not control viruses. 21 day PHI.
	Provado 1.6F at 3.75 fl. oz. per acre. OR	Do not exceed 18.75 fl. oz. per acre per season. Allow 5 days between applications. 0 day PHI.
	Fulfill 50WG at 2.75 oz. per acre. OR	Do not exceed 5.5 oz. per acre per season. 14 day PHI.
	Orthene 75S at 0.67 to 1.33 lb. per acre. OR	7 day PHI.
	Metasystox-R at 2 pt. per acre. OR	Do not exceed 2 applications per season. 3 day PHI.
	Actara 25WDG at 2 to 3 oz. per acre. OR	Do not exceed 8 oz. per acre per season. 0 day PHI.
	Dimethoate at 0.75 to 1 pt. per acre. OR	Use sufficient water to assure good coverage of plants. 0 day PHI.
	Lannate LV at 1.5 to 3 pt., or 90SP at 0.5 lb. per acre. OR	3 day PHI.
	Thiodan, Endosulfan, or Phaser 50WP at 1 to 2 lb. or 3EC at 0.6 to 1.3 qt. per acre. OR	Use sufficient water to assure good coverage of plants. Maximum of 2 applications per season. 4 day PHI, 1 day if less than 1 lb. applied.
	M-Pede at 1 to 2% by volume.	Must contact aphids to be effective. 0 day PHI.
Whiteflies	Platinum 2SC at 5 to 8 fl. oz. per acre. OR	Do not exceed 8.0 fl. oz. per acre per season. 30 day PHI.
	Admire 2F at 16 to 32 fl. oz. per acre. OR	Do not exceed 0.5 lb. a.i. of Admire or Provado per acre per season. 21 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Whiteflies (cont.)	Provado 1.6F at 3.75 fl. oz. per acre.	Do not exceed 18.75 fl. oz. per acre per season. Allow 5 days between applications. 0 day PHI.
	OR	
	Align or Neemix according to label directions.	0 day PHI.
	OR	
	M-Pede at 1 to 2% by volume.	Use sufficient spray to wet all infested plant surfaces. Must contact whiteflies to be effective. 0 day PHI.
	OR	
	Actara 25WDG at 3 to 4 oz. per acre.	Do not exceed 8 oz. per acre per season. 0 day PHI.
	OR	
	Capture 2SC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 7 day PHI.

Potato

Varieties	Season	Use	Scab Resistance	Appearance and Comments
Dark Red Norland	Very Early	Market & Home	Good	Dark, deep red; smooth skinned; shallow eyes medium in number
Red Norland	Very Early	Market & Home	Good	Bright red, oblong, and smooth skinned, shallow eyes medium in number
Superior	Early	Chips & Market	Very Good	White, slight russet, oval; very popular.
Russet Norkotah	Early	Market & home	Fair	Very good appearance, good baking quality with fair specific gravity
Cascade	Mid-season	Market & Home	Good	White, round shape
Goldrush	Mid-season	Market & Home	Fair	Very good appearance, good baking quality with fair specific gravity
Snowden	Mid-season	Chips & Market	Good	White, very high dry matter, ideal for baking and french fries; exceptional ability to produce white potato chips Tubers sometimes rough.
Atlantic	Late	Chips & Market	Good	White, blocky-round, high yield; hollow heart, internal browning, high specific gravity
Katahdin	Late	Market & Home	Fair	White, smooth, round, shallow-eyed.
Kennebec	Late	Chips	Fair	White, long, oval
Red Pontiac	Late	Home garden	Fair	Red, round, very high yield, low specific gravity, good boiling, mashing type
Russet Burbank				
For Trial Only:				
Conestoga	Early			A white type with good shelf life, shape, and baking quality
Somerset	Mid-season			Blocky shape, very good appearance, high specific gravity, chips well, white
Yukon gold	Early	Local market & home		Yellow flesh, good size

Spacing

Rows 34 to 36 in. apart. Seed pieces 9 to 11 in. apart in row, depending on variety and intended use. Seed 16 to 18 100 lb. bags per acre. Seed piece should be 1.5 to 2 oz. Using B-size certified seed will save cutting labor and reduce tuber-borne diseases.

Fertilizing

Lime: To control common scab, soil pH should be within 5.0 to 5.2. However, low soil pH reduces availability of phosphorus and increases availability of toxic elements such as manganese and aluminum. If the field has a history of scab, the use of scab-resistant varieties is recommended. Then the soil pH can be 6.5 where phosphorus is most available.

Preplant: N, none - only a small amount such as 24 to 30 lb. with the starter fertilizer; P_2O_5, none - apply 50 to 150 lb. as a starter depending on the soil test results; K_2O, 50 to 400 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. For the most efficient phosphate application, apply the fertilizer at planting in a band 2 to 3 inches to the side and below each side of the tuber. Examples would be 500 lb. per acre of 6-24-24 or 8-16-16. Do not apply more than 200 lb. of K_2O per acre in the band at planting. On sandy soils, broadcast 30 lb. or band 15 lb. sulfur per acre.

Sidedress N: For irrigated sandy soils, two split N applications are recommended: 1/2 at emergence and 1/2 at hilling or tuber initiation. For the early maturing varieties, use 50 to 60 lb. of N per acre at each growth stage. The second application can be adjusted according to rainfall and a petiole nitrate-N analysis. For the upland or finer-textured soils, all of the required N can be applied preplant or shortly after emergence. For soils with more than 3% organic matter and following soybeans, alfalfa, or a grass-legume hay crop, apply 100 lb. N per acre. For soils with less than 3% organic matter and the above rotation, apply 135 lb. N per acre. For potatoes following corn, rye, oats, wheat, or a vegetable crop, apply 150 lb. N per acre. Refer to University of Minnesota recommendations for N rates adjusted for yield goal.

VINE KILLING PRODUCT	TREATMENT	COMMENTS
Desicate II	1.5 to 2 qt. per acre.	Apply 10 - 14 days before harvest.
paraquat (2.5 lb./gal.)	Apply 13 to 24 fl. oz. per acre in 50 to 100 gal. of water plus 8 to 32 fl. oz. of a nonionic spreader (such as X-77 or AG-98) per 100 gal. of water.	Begin application when leaves begin to turn yellow. Immature potato foliage and drought stressed potato foliage are tolerant to this product. *This product cannot be used to desiccate potato vines when potatoes are to be stored or used for seed.* Make no more than 2 applications with 5 days between applications. Read the label for complete instructions. RUP. Not for use in Iowa or Missouri. 2 day PHI.
Reglone	1 to 2 pt. in 20 to 100 gal. water plus 8 to 64 fl. oz. nonionic surfactant.	A second application can be made if necessary. Allow at least 5 days between applications. 7 day PHI.
Defol 5L	4.8 qt. per acre in 10 to 20 gal. water by ground or 5 to 10 gal. by air.	Apply 10 days before harvest. Do not apply in extreme heat during middle of the day.

CHEMICAL SPROUT CONTROL

Use maleic hydrazide (MH-30) according to label directions 1 week after blossoms fall. For varieties and conditions where flowering does not occur, apply 4 to 6 wks. before potatoes are mature and ready for harvest. Make only 1 application. Apply when no rain is expected for 24 hrs. Potatoes treated with MH cannot be used for seed because sprouting will be inhibited. Follow label directions.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Blackleg	Plant cut seed tubers that have been stored under conditions for rapid healing of cut surfaces and treated with a labeled potato seed treatment.	Plant whole seed tubers where possible.
Early blight	Bravo Ultrex: low rate 0.7 lb. per acre, high rate 0.9 to 1.4 lb. per acre. OR	Begin applications at the low rate when vines are exposed to disease and leaf wetness occurs. Repeat applications at the higher rates at 7 day intervals when vines close between rows or crop reaches 300-P days.

DISEASES CONTROLLED	CONTROL METHOD	COMMENTS
Early blight (cont.)	Bravo Weather Stik: low rate 0.75 pt. per acre, high rate 1 to 1.5 pt. per acre. OR Bravo 500: low rate 1 pt. per acre, high rate 1.5 to 2 .13 pt. per acre. OR Terranil Cu. low rate 1.7 pt. per acre, high rate 2.25 to 3.4 pt. per acre. OR Echo75 WDG at 1.2 to 1.5 lb. per acre. OR Dithane, Manzate, Penncozeb, or Manex II or Gavel 75DF. Rates vary widely with product and formulation.	Avoid droughty, wet, or compacted soils and other conditions (such as insufficient nitrogen) that might add undue stress to the crop and increase the susceptibility to early blight. 48 hour REI and 7 day PHI for Bravo, Terranil, and Echo. 24 hour REI and 14 day PHI for Dithane, Manzate, Penncozeb. 24 hour REI and 14 day PHI for Rovral.
	Omega 500F at 5.5 to 8 oz. per acre. OR	Start applications when plants are 6 to 8 inches tall. May be effective when used in rotation with other pesticides labeled for early blight. Use 7 to 10 day interval. 14 day PHI.
	Rovral at 1/3 to 1 1/3 lb. per acre for dry formulations and 1 to 2 pt. per acre for flowable formulations. use a 7-10 day spray interval. OR	Do not exceed 4 applications or 2.88 qt. per acre per season. 14 day PHI.
	Quadris 2.08SC at 6.2 to 15.4 fl. oz. per acre for 7 day spray intervals or 12.4 oz. per acre for 14 day intervals.	Do not apply more than 1 application of Quadris before alternating with a fungicide with a different mode of action such as Bravo, Dithane, Rovral or Super Tin.
	Super Tin 80WP at 2.5 to 3.75 oz. per acre.	48 hour REI. 7 day PHI.
Fusarium dry rot	Mertect 340-F (2.5 pt. per 100 gal.). Treat potatoes as they go into storage.	The product should be applied uniformly as a fine mist. Avoid bruising at harvest. Cure potatoes in storage at 60°F before lowering temperature. Provide adequate ventilation.
Late blight	Destroy all potato cull piles.	
	Bravo, Terranil, or Echo at 2 to 3 pt. per acre for flowable (F) formulations or 1.5 to 2.5 lb. per acre for dry (DF, DG) formulations. OR	48 hour REI. 7 day PHI.

DISEASES CONTROLLED	CONTROL METHOD	COMMENTS
Late blight (cont.)	Dithane, Manzate, Penncozeb, or Manex II at 2 to 3 pt. per acre for flowable (F) formulations or 2 to 3 lb. per acre for dry (WP, DF, DG) formulations.	24 hour REI and 14 day PHI for all Mancozeb products.
	OR	
	Super Tin 80WP at 2.5 to 3.75 oz. per acre.	48 hour REI. 7 day PHI.
	OR	
	Acrobat MZ at 2.25 lb. per acre.	Use Acrobat or Curzat only in combination with a protectant fungicide. 14 day PHI.
	OR	
	Curzate 60DF at 3.2 oz. per acre.	
	OR	
	Omega 500F at 5.5 oz. per acre.	Start applications when plants are 6 to 8 inches tall. May be effective when used in rotation with other pesticides labeled for late blight. Use 7 to 10 day interval. 14 day PHI.
	OR	
	Ridomil Gold Bravo at 2.0 lb. or Ridomil Gold MZ at 2.5 lb. per acre. Use 3 applications at intervals. Use a 14 day spray interval.	Apply when plants are 8 to 12 in. tall. Apply Ridomil at the first substantiated report of late blight in the area. 48 hour REI. 14 day PHI.
	OR	
	Quadris 2.08SC at 6.2 fl. oz. per acre on a 7 day schedule alternating with other fungicides. If late blight develops or conditions favor the disease, increase the rate to 12.4 to 15.4 fl. oz. per acre, and use a 5 day schedule.	Do not exceed 6 applications or 2.88 qts. per acre per season. 14 day PHI.
Rhizoctonia canker	Avoid heavily infested fields, and plant uncontaminated seed tubers.	
Scab	Plant resistant varieties. Follow 3-4 year rotation schedule.	Maintain high moisture levels (near field capacity) during tuber set and enlargement. Do not apply manure or other organic matter immediately before planting. Avoid excessive liming, and maintain acid soil pH.
Verticillium wilt	Employ at least a 2 year rotation with small grains to manage fungus populations in the soil.	Good weed control also is important in reducing pathogen populations.
Virus diseases and purple-top wilt (Aster yellows)	Plant only certified seed tubers. Control aphids and leafhoppers with insecticides.	Practice clean cultivation. Rogue first infected plants, including tubers.

DISEASES CONTROLLED	CONTROL METHOD	COMMENTS
Root-knot and lesion nematodes	Methyl bromide or Sodium methyl dithiocarbamate or Vydate L.	Sample fields during growing season for plant parasitic nematodes before planting. Avoid fields with high numbers of root-knot and/or lesion nematodes. Methyl bromide and sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate gives adequate control when nematode populations are low to moderate.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	3 to 8 lb. per acre on coarse-textured soils (less than 2% organic matter), 14 lb. per acre on fine-textured soils in at least 50 gal. of water per acre.	Apply preemergence immediately after planting or drag-off. Use 50-mesh or larger screens. Not effective on muck soil.
Dual Magnum, Dual II Magnum	1 to 2 pt. per acre. Apply before planting, and incorporate, or after planting and before weeds emerge. May also apply 1.67 pt. per acre after hilling.	Dual might delay maturity and/or reduce yield of Superior and other early maturing potato varieties if cold wet soil conditions occur after treatment. Dual can be tank-mixed with Lorox, Lexone or Sencor, Prowl 4E or Eptam. See label. 60 day PHI if applied before drag-off. 40 day PHI if applied at lay-by.
Trifluralin (4 lb. /gal.)	1 to 2 pt. per acre.	Apply after planting and incorporate uniformly. Not effective on muck and other high organic matter soils.
Eptam 7E or 10G	3.5 to 7 pt. per acre of 7E, or 30 to 40 lb. per acre of 10G.	Apply before planting, after drag-off, or as directed spray at lay-by. Incorporate immediately. On muck, supplement with Lorox or Sencor/ Lexone applied before crop emerges and after drag-off. Superior variety may be sensitive. Effectively suppresses nutsedge. 45 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
Sencor	1 pt. per acre of 4F (0.67 lb. 75 DF) on coarse-textured soils (2% or more organic matter), 2 pt. per acre of 4F (1.3 lb. 75 DF) on fine-textured soils and muck.	Apply just before crop emergence and, if practical, after drag-off.
Lorox 50DF	1.5 lb. per acre on coarse-textured soils (1 to 2% organic matter), 4 lb. per acre on fine-textured soils and muck.	Apply after planting, before crop emergence, after drag-off. Do not use on soils below 1% organic matter. Apply when weeds are less than 2 in. tall.
Prowl 3.3E, Pendimax 3.3E	1.2 to 3.6 pt. per acre.	Apply preemergent, preemergent incorporated, or early postemergent. Do not use early post on potatoes that are stressed. Do not use on muck soils.
Matrix 25 DF	1 to 1.5 fl. oz. per acre.	Apply preemergence at hilling, drag-off, or reservoir tillage (dam/dike operation), to a clean, newly prepared seedbed. No varietal restrictions. 60 day PHI.
POSTEMERGENCE		
Sencor	1 pt. per acre of 4F, or 0.67 lb. per acre of 75DF.	Apply postemergence over the top of the potatoes. Avoid spraying during the 12 to 15 in. stage of growth. Do not apply within 3 days of cool, wet, or cloudy weather, or crop injury may occur. Not for use on early maturing or redskin varieties, on within 1 day of other pesticides, or more than 1 lb. a.i. per acre per year. May cause injury to sensitive crops the following year. Check label for sensitive varieties. 60 day PHI.
Poast 1.5E	1 to 1.5 pt. per acre plus 1 pt. nonionic surfactant.	Apply to actively growing grass. Do not exceed 5 pt. per acre per season. 30 day PHI.
Matrix 25DF	1 to 1.5 fl. oz. per acre.	Apply postemergence to young actively growing weeds after crop emergence. No varietal restrictions. 60 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE (cont.)		
Select 2EC	6 to 16 fl. oz. per acre; plus 1 qt. COC per 25 gal. spray solution (1% v/v).	Apply to actively growing grasses. maximum 32 fl. oz. per season. 30 day PHI.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	1.5 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before or after planting but before crop emerges. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before crop emerges in spring or after final harvest. These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Colorado potato beetle	Crop Rotation.	Planting fields as far as possible from last year's potato fields will reduce potato beetle damage.
	Scouting.	Regular (weekly) scouting of fields will allow you to determine the necessity for, and improve the timing of, insecticide treatments.
	Soil applied or seed piece treatments.	
	Platinum 2SC at 5 to 8 fl. oz per acre.	Apply directly to seed piece in sufficient water to cover entire seed piece. Provides season long control of potato beetles and aphids at higher label rates. Do not exceed 8.0 fl. oz. per acre per season. 30 day PHI.
	OR	
	Admire 2F at 0.9 to 1.3 fl. oz. per 1000 feet of row.	Apply directly to seed piece or below seed piece at planting. Can expect good control of 1st generation potato beetle and 70-90 days of aphid control. Do not exceed 0.31 lb. a.i. of Admire and/or Provado per acre per season.
	OR	

Allowable defoliation from Colorado Potato Beetles

Preflowering	20-30%
Flowering	5-10%
Tuber formation	30%

INSECTS CONTROLLED	TREATMENT	COMMENTS
Colorado potato beetle (cont.)	Genesis FL at 0.6 to 0.8 fl. oz. produce per cwt. seed. OR Gaucho MZ at 0.75 lb. per cwt. seed. OR *Foliar applied products*.	**Not for leafhoppers.** Provides season-long control of green peach aphid at higher label rates.
	Provado 1.6F at 3.75 fl. oz. per acre. OR	Do not use Provado if Admire was used. Allow 7 days between applications. 7 day PHI.
	Agri-Mek 0.15EC at 8 to 16 fl. oz. per acre. OR	Do not exceed 32 fl. oz. per acre per season. No more than 2 sequential applications. 14 day PHI.
	Asana XL at 5.8 to 9.6 fl. oz. per acre. OR	Do not exceed 0.35 lb. a.i. per acre per season. Do not grave livestock on treated vines. 7 day PHI.
	Ambush 2 EC at 3.2 to 12.8 fl. oz. or 25WP at 3.2 to 12.8 fl. oz. per acre, or Pounce 3.2EC at 4 to 8 fl. oz. or 25WP at 6.4 to 12.6 oz. per acre. OR	Do not exceed 1.6 lb. a.i. Ambush or Pounce per acre per season. Also for tarnished plant bug and cutworms. 14 day PHI.
	Furadan 4F at 1 to 2 pt. per acre. OR	Do not make more than 2 applications per season. 14 day PHI.
	Monitor 4EC at 1.5 to 2 pt. per acre. OR	Should also control cutworms and aphids. 14 day PHI.
	Thiodan, Endosulfan, or Phaser 50WP at 1 lb. or 3EC at 0.67 to 1.33 qt. per acre. OR	Do not exceed 6 applications or 3 lb. a.i. per acre per season. 1 day PHI.
	Imidan 70WP at 1.3 lb. per acre. OR	7 day PHI.
	Kryocide or Cryolite 96 at 10 to 12 lb. per acre. OR	Apply by air in 20 gal. or by ground in 25-100 gal. water per acre at minimum of 7 day intervals. Do not exceed 96 lb. per acre per season. 0 day PHI.
	M-Trak at 1.5 to 4.0 qt., Novodor at 1.0 to 4.0 qt., or Raven at 0.5 to 3 qt. per acre. OR	*Bacillus thuringiensis* based insecticides. **Small Colorado potato beetles larvae only.** 0 day PHI.
	SpinTor 2SC at 3 to 6 fl. oz. per acre. OR	Do not exceed 21 fl. oz. per acre per season. Do not apply to consecutive generations of Colorado potato beetle or make more than 2 applications to a single generation. 7 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Colorado potato beetle (cont.)	Baythroid 2E at 0.8 to 2.8 fl. oz. per acre.	Do not exceed 6 applications or 16.8 fl. oz. per acre per season. 0 day PHI.
	OR	
	Actara 25WDG at 1.5 oz. per acre.	Do not exceed 3 oz. per acre per season. 14 day PHI.
	OR	
	Leverage 2.75E at 3.75 fl. oz. per acre.	7 day PHI.

RESISTANCE MANAGEMENT

Populations of Colorado potato beetles are resistant to many insecticides in some areas of the Midwest. If a previously effective insecticide is no longer effective, consider switching to another chemical class. If insecticides are still effective, alternating between classes will help prolong their effective life. If planting time applications of neonirotinoids (Admire, Platinum, Genesis, Gaucho) are used, foliar neonirotinoids (Provado, Actara, Leverage) should not be used.

The following table shows to active ingredients and chemical classes of Colorado potato beetle insecticides and should be used to make resistant management decisions.

Insecticide	Active Ingredient	Chemical Class
Actara	thiamethoxam	neonicotinoid
Platinum	thiamethoxam	neonicotinoid
Admire	imidacloprid	neonicotinoid
Genesis	imidacloprid	neonicotinoid
Gaucho	imidacloprid	neonicotinoid
Provado	imidacloprid	neonicotinoid
Leverage	imidacloprid + cyfluthrin	neonicotinoid + pyrethroid
Baythroid	cyfluthrin	pyrethroid
Ambush	permethrin	pyrethroid
Pounce	permethrin	pyrethroid
Agri-Mek	abamectin	GABA agonist
Furadan	carbofuran	carbamate
Monitor	methomidaphos	organophosphate
Imidan	phosmet	organophosphate
Thiodan, Endosulfuran, Phaser	endosulfan	cyclodiene
Kryocide, Cryolite	sodium aluminofluoride	mineral
M-Trak, Novodor, Roven	*Bacillus thuringiensis*	bacterium
Spin Tor	spinosad	

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea Beetles **Flea Beetle Threshold** 2/sweep	Asana, Ambush, Pounce, Furadan, Monitor, Imidan, Kryocide, Baythroid, Actara, or Leverage as described for Colorado potato beetles. OR Sevin XLR Plus or 4F at 0.5 to 1 qt. or 80S at 0.67 to 1.25 lb. per acre.	Be sure to check PHI. 0 day PHI.
Potato leafhopper **Potato Leafhopper Thresholds** 1.5 adults per sweep 1.0 adults per sweep and nymphs present 1 nymph per 10 leaves	*Soil applied or seed piece treatment materials.* Admire 2F at 0.9 to 1.3 fl. oz. per 1000 feet of row. OR Platinum 2SC at 5 to 8 fl. oz. per acre. *Foliar applied materials.* Conserve natural enemies. Asana XL at 5.8 to 9.6 fl. oz. per acre. OR Ambush 2EC at 3.2 to 12.8 fl. oz. or 25WP at 3.2 to 12.8 fl. oz. per acre, or Pounce 3.2EC at 4 to 8 fl. oz. or 25WP at 6.4 to 12.6 oz. per acre. OR Imidan 70WP at 1.3 lb. per acre. OR Kryocide or Cryolite 96 at 10 to 12 lb. per acre OR Baythroid 2E at 0.8 to 2.8 fl. oz. per acre. OR Actara 25WDG at 1.5 oz. per acre.	 Apply directly to seed piece or below seed piece at planting. Can expect 40-50 days of control. Do not exceed 8 fl. oz. per acre per season. Apply directly to seed piece in sufficient water to cover entire seed piece. Can expect 90-110 days of control. Repeated use of pyrethroids carbomates, and organophosphates will flare green peach aphids. Do not exceed 0.35 lb. a.i. per acre per season. Do not graze livestock on treated vines. 7 day PHI. Do not exceed 1.6 lb. a.i. Ambush or Pounce per acre per season. Also for tarnished plant bug and cutworms. 14 day PHI. 7 day PHI. Apply by air in 20 gal. or by ground in 25-100 gal. water per acre at minimum of 7 day intervals. Do not exceed 96 lb. per acre per season. 0 day PHI. Do not exceed 6 applications or 16.8 fl. oz. per acre per season. 9 day PHI. Do not exceed 3 oz. per acre per season. 14 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids (green peach aphid, melon aphid and others)	Conserve natural enemies.	Limiting the use of insecticides will conserve predators and parasites that help control aphid populations.
	Seed applied or seed piece treatment materials.	
	Admire 2F at 0.9 to 1.3 fl. oz. per 1000 feet of row.	Apply directly to seed piece or below seed piece at planting. Can expect 70-90 days of control.
	OR	
	Platinum 2SC at 5 to 8 fl. oz. per acre.	Do not exceed 8 fl. oz. per acre per season. Apply directly to seed piece in sufficient water to cover entire seed piece. Can expect 90-110 days control.
Threshold Prebloom - 2/leaf Postbloom - 4/leaf	*Foliar applied materials.*	
	Provado 1.6F at 3.75 fl. oz. per acre.	Do not use if Admire or Platinum were used at planting. Do not exceed 15 fl. oz. per acre per season. Allow 7 days between treatments. Controls green peach aphid. 7 day PHI.
	OR	
	Dimethoate at 0.75 to 1.5 pt. per acre.	Repeat applications as necessary. Controls leafhoppers. **Not for green peach or melon aphid.** 0 day PHI.
	OR	
	Lannate LV at 1.5 to 3 pt. per acre.	**Not for green peach or melon aphid.** 6 day PHI.
	OR	
	M-Pede at 1 to 2% by volume.	Must contact aphids to be effective. **Not for green peach or melon aphid.** 0 day PHI.
	OR	
	Pounce 3.2 EC at 4 to 8 fl. oz. or 25 WP at 6.4 to 12.8 oz. per acre.	Potato aphid only. Do not exceed 1.6 lb. a.i. per acre per season. 14 day PHI.
	OR	
	Fulfill WG at 2.75 oz. per acre.	Requires up to 7 days to see results. Best control achieved with more than 45 gallons water per acre. Do not exceed 5.5 oz. per acre per season. 14 day PHI.
	OR	
	Leverage 2.7 SE at 3.75 fl. oz. per acre.	Do not use if Admire or Platinum were used at planting. 7 day PHI.
	OR	
	Actara 25WG at 1.5 oz. per acre.	Do not exceed 3 oz. per acre per season. 14 day PHI.
	OR	
	Monitor, Thiodan, Vydate as described earlier.	Thiodan will control melon aphid.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cutworms	Sevin 5B at 40 lb. per acre.	7 day PHI.
	Monitor 4EC at 2 pt. per acre.	Will also control aphids. 14 day PHI.
Wireworms	Site selection.	Wireworms are most likely to be a problem in fields recently planted to sod or pasture, or in fields that have had a grassy weed problem.
	Sampling.	Check for the presence of wireworms by burying a potato 6 in. deep in 5 locations per field prior to planting. Mark the spots with a flag. Dig the potatoes and inspect for wireworms 7 days later.
	Apply before planting or at time of planting:	No effective treatment after planting. Treatment at planting may only provide 65% control.
	Thimet 20G at 11.3 oz. per 1000 linear ft. of row for any row spacing (minimum 32 in. spacing) in light or sandy soils, 17.3 oz. per 1000 feet of row in heavy or clay soils.	Apply as a band application on each side of row and beneath the soil surface, or in the seed furrow. Also controls early season aphid and leafhopper infestations. 90 day PHI.
European corn borer	Asana XL at 5.8 to 9.6 oz. per acre.	Repeat as necessary to maintain control. Do not exceed 0.35 lbs. a.i. per acre per season. 7 day PHI.
	OR	
	Pounce 3.2 EC at 4 to 8 oz. per acre.	Do not apply more than 1.6 lbs. a.i. per acre per season. 14 day PHI.
	OR	
Threshold 1 egg mass/25 leaves	Furadan 4F at 1 to 2 pts. per acre.	Apply when insects first appear, and repeat as necessary to maintain control. Do not make more than 2 foliar applications per season. Do not apply to foliage if Furadan was used at planting. 14 day PHI.
	OR	
	SpinTor 2SC at 3 to 6 fl. oz. per acre.	Do not exceed 21 fl. oz. per acre per season. 7 day PHI.

Rhubarb

Varieties

McDonald, Sutton, Valentine (produces fewer seed stalks than McDonald) – all red-fleshed varieties.

Planting and Spacing

Crowns: Use only young, healthy crowns having preferably 2 or 3 buds. Rows: 5 to 6 ft. apart. Set crowns in rows 3 ft. apart in shallow furrows so crowns will be 2 in. below surface.

Age for Harvesting

Harvest no longer than 4 weeks, beginning with the third season of growth. Harvest for about 8 to 10 weeks after the third season. Do not remove more than 2/3 of the developed stalks from any plant at one time.

Bolting (Seed Stalk Formation)

Infertile soil, extreme heat or cold, drought, or long days that expose plants to too much light may cause bolting. Old plants bolt more. Valentine is more sensitive than McDonald, Ruby, and most green-stalked varieties.

Fertilizing

Lime: To maintain a soil pH of 6.2 to 6.8.

Preplant: N, 50 lb. per acre; P_2O_5, 0 to 150 lb. per acre; K_2O, 0 to 200 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. Apply 25 lb. of additional P_2O_5 directly in furrows when setting the rootstalks (divided crowns).

Yearly: Only N needed. Broadcast 50 lb. N per acre before beds are worked in the spring. Topdress with 35 lb. N per acre after new growth resumes.

DISEASES Controlled	Treatment	Comments
Ascochyta leaf spot	Fertilize in fall for growth in the spring.	Remove older, yellowed leaves or leaves with lesions in the fall.
Crown rot	Use disease-free plants.	Plant only on well-drained soil.

Herbicide*	Treatment**	Comments
PREEMERGENCE		
All weeds	Before spring growth, harrow bed thoroughly but carefully to avoid injuring the crowns. During growing season, cultivate row middles and hand hoe to keep the planting clean.	Mix in fertilizer with soil surface. Following first light freezes in fall, mulch with 3 to 4 in. of strawy manure around plants, but not on crowns. If added mulch is needed next spring, apply before hot, dry weather. Add more during summer if needed to control weeds and retain moisture.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Do not apply more than 3 pt. per acre per season. 15 day PHI for IL, IN, MI, MN, and WI; 30 day PHI for other states.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre, plus 1qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	For use on dormant rhubarb. Use higher rates for heavy weed infestation. Do not exceed 2 sprays per season. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. For use on dormant rhubarb. These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Common stalk borer, Rhubarb curculio	There are no registered insecticides that will give adequate control.	Control by cultivating field and margins. Remove curly dock, the normal host of rhubarb curculio.
Cutworms, European corn borer	Pounce 3.2EC at 4 to 8 fl. oz. or 25W at 6.4 to 12.8 oz. per acre. OR Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre.	Apply every 3-5 days or as needed in sufficient water to obtain full coverage of foliage. Do not exceed 2 lb. a. i. per acre per season. 1 day PHI.
	OR	
	Larvin 3.2AF at 16.0 to 30.0 fl. oz. per acre.	Do not exceed 60 fl. oz. per acre per season. 14 day PHI.
	OR	
	SpinTor 2 SC at 4 to 8 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. 1 day PHI.

ROOT CROPS

Beet, Carrot, Parsnip, Radish and Turnip

Varieties

Beets: Ruby Queen, Crosby Greentop, Red Ace, Asgrow Wonder, Rosette.

Carrots: **Imperator:** Premium, First Class, Avenger, Apache, Condor, Six-pack II, Navaho.
Dicer types: Red Cored Chantenay, Goliath, Royal Chantenay, Danvers 126, Gold King.
Slicer types: Heritage, Protege, PY 60 Improved.

Parsnips: Harris' Model, Andover, Anoka.

Radishes: Cherry Belle, Comet, Red Prince.

Turnips: Purple Top White Globe, Seven Top (greens).

Spacing

Beets: Rows 18 to 24 in. apart. Seed 8 to 10 lb. per acre for bunching.

Carrots: Rows 16 to 30 in. apart. 20 to 30 plants per foot for slicing/fresh market; 10 to 20 plants per foot for dicing.

Parsnips: Rows 18 to 24 in. apart. Seed: 2 to 3 lb. per acre.

Radishes: Rows 15 in. apart. Plant 12 to 15 per foot of row. Seed 10 to 15 lb. per acre.

Turnips: Rows 14 to 18 in. apart. Plant 2 to 3 in. apart in row. Seed 1 to 2 lb. per acre.

Fertilizing

Lime: To maintain a soil pH of 6.0 to 6.8. Slightly higher for beets at 6.5 to 7.0.

Preplant: N, 60 lb. per acre; P_2O_5, 20 to 160 lb. per acre; K_2O, 0 to 200 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. If the soil test indicates a high amount of K is necessary, plow down at least 50% of the requirement. Beets also respond to boron when grown on sandy soils, light-colored silt and clay loams, and alkaline, dark-colored soils. It may be omitted from acid, dark-colored soils. Based on a boron soil test, include boron at 2 1/2 to 5 lb. per acre applied over the row at planting. Do not contact with seed. Boron is toxic to many vegetables, particularly beans, peas, and cucurbits. Thus, rotational plans may have to be adjusted. For carrots grown on muck soil with a soil pH greater than 6.0, add 6 lb. of Mn per acre.

Sidedress N: Beets, carrots, parsnips: for soils with more than 3% organic matter and following soybeans, alfalfa or a grass-legume hay crop, apply 30 lb. N per acre 4 to 6 weeks after planting. For soils with less than 3% organic matter and the above rotation, apply 45 lb. N per acre. Following corn, rye, oats, wheat, or a vegetable crop, apply 60 lb. N per acre. Radish, turnip: none needed.

DISEASES Controlled	Treatment	Comments
Alternaria leaf blight and Cercospora leaf blight	3-4 year crop rotation.	Start applying protective fungicides at the first sign of disease.
	Several chlorothalonil brands and formulations exist including Agronil 720, Bravo 500, Equus DF, Echo 75WDG. Rates vary between carrots and parsnips.	**Carrots and parsnips only.** 0 day PHI (carrot), 10 day PHI (parsnip).
	OR	
	Rovral at 1 to 2 pt. per acre for flowable (F) formulations, or 1/3 to 1 1/3 lb. per acre for dry formulations.	Use low rate when tank mixed with another fungicide registered for use on carrot. Apply on 7-14 day interval. Make no more than 4 applications per season. **Carrots only.** 0 day PHI.
	OR	
	Quadris Flowable is labeled at 9.2 to 20.3 fl. oz. per acre for carrot. See label for specific information on other root crops.	Resistance management information varies depending on root crop and disease. See label. 4 hour REI. 0 day PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Downy Mildew	3 year crop rotation.	Avoid volunteer plants and cruciferous weeds.
	Plow harvest as soon as possible after harvest.	
	Turnip only: Aliette WDG at 2 to 3 lbs. per acre.	Use on a 7 to 21 day schedule. 12 hour REI. 3 day PHI.
White mold **(carrot and parsnip)**	3-4 year crop rotation.	Avoid including beans, cucurbits, celery, and late cabbage in the rotation.
Aster yellows **(carrot and parsnip)**	Use an insecticide to control leafhoppers that transmit the disease.	Excellent early season leafhopper control is essential. Control must occur before leafhoppers feed.
Root-knot nematode	Methyl bromide or Sodium methyl dithiocarbamate or Vydate L (carrots only).	Sample fields for plant parasitic nematodes before planting. Avoid fields with high numbers of root-knot nematodes. Methyl bromide and sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate gives adequate control when populations are low to moderate.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Beets:		
Ro-neet 6E	2 to 2.67 qt. per acre.	Apply before planting, and incorporate immediately by double discing or other method. Mineral soils only.
Pyramin 4.5SC or 65DF	2.75 to 3.25 qt. per acre of SC, or 4.6 to 5.4 lb. per acre of DF.	Apply after planting. Rainfall or irrigation necessary for activation.
Carrots and Radishes:		
Trifluralin	1 to 1.5 pt. per acre.	**Mineral soil only.** Apply before planting, and incorporate 2-3 in. soon after spraying. Use low rates on sandy soils.
Horseradish:		
Dacthal 75WP	6 to 8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on other soils.	Apply uniformly at planting time.
Goal 2XL	2 pt. per acre.	Apply after planting prior to crop emergence.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE (cont.)		
Turnips:		
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 11 lb. on darker soils in at least 50 gal. water per acre.	Apply immediately after seeding. Use 50-mesh or larger screens. Not effective on muck and other high organic soils.
Parsnips:		
Lorox 50DF	1.5 lb. per acre on light-colored soils (less than 2% organic matter), 3 lb. on darker colored soils.	Apply before parsnips emerge.
POSTEMERGENCE		
Beets:		
Spin-aid 1.3E	3 to 6 pt. per acre in 11 to 22 gal. of water.	Apply to red beets with 4 true leaves to avoid injury. Do not apply if beets are stressed. Does not control pigweed. 60 day PHI.
Pyramin 4.5SC	3.25 qt. per acre.	Timing is very important. Treat after beets have 2 expanded leaves and weeds have 2 to 4 leaves.
Carrots:		
Sencor 4F or 75 DF	0.5 pt. per acre of 4F or 0.33 lb. per acre of 75DF.	Broadcast when carrots have 5 to 6 leaves. Do not apply within 3 days of cool cloudy weather or other pesticide application, or when temperature is above 85°F. Do not tank mix. Only one application per season if carrots are rotated with onions. 60 day PHI.
Lorox 50DF	1 to 2 lb. per acre.	Apply when crop is at least 3 in. tall. Do not apply if temperatures exceed 85°F. Do not exceed 4 lb. per acre per season. 14 day PHI.
Fusilade DX 2E	10 to 12 fl. oz. per acre. Plus 1 pt. nonionic surfactant.	Apply to actively growing grass. Best control if applied at less than 30 gal. per acre. Check label for specific grasses controlled. 45 day PHI.
Select 2EC	6 to 8 fl. oz. for annual grasses; 8 fl. oz. for perennial grasses; plus 1 qt. COC per 25 gal. spray solution (1% v/v).	Apply to actively growing grasses. Wait at least 14 days between applications. Maximum 32 fl. oz. per season. 30 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE (cont.)		
Beets (root), Carrots, Horseradish		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Do not exceed 5 pt. per acre per season. 30 day PHI for carrots, 60 day PHI for beets and horseradish.
NON-SELECTIVE HERBICIDES		
Carrots and Turnips:		
paraquat (2.5 lb./gal.)	2 to 3 qt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before or after planting, but before crop emerges. RUP.
Beets, Carrots, Horseradish, Parsnips, Radishes, and Turnips:		
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before crop emerges. These rates are for annual weeds at application volumes of 10 to 40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Carrots:		
Leafhoppers	Resistant varieties.	Use varieties resistant to aster yellows.
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 5 applications per season. Allow 7 days between applications. 0 day PHI.
Threshold For susceptible varieties - 20 leafhoppers per 100 sweeps	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 96 fl. oz. per acre per season. 7 day PHI.
	OR	
	Methoxychlor 2EC at 2 to 4.5 qt. per acre.	14 day PHI.
	OR	
	Sevin 50WP at 2 lb. or XLR Plus at 1 qt. per acre.	Treat field margins and fields for best control. 7 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Carrots (cont.):		
Cutworms Threshold 25% of plants infested	Baythroid 2E at 1.6 fl. oz. per acre. OR Asana XL at 5.8 to 9.6 fl. oz. per acre.	See restrictions under leafhoppers. 0 day PHI. Do not exceed 96 fl. oz. per acre per season. 7 day PHI.
Aphids	Diazinon 50WP at 1 lb. per acre. OR M-Pede at 1 to 2% by volume. OR Thiodan 3EC at 0.7 to 1.3 qt. per acre.	14 day PHI. Must contact aphids to be effective. 0 day PHI. Limit of one application per year. 7 day PHI.
Beets:		
Variegated cutworm	Lannate LV at 1.5 pt. or 90SP at 0.5 to 1 lb. per acre.	PHI: roots– 0 days; tops–14 days.
Aphids	Diazinon 50WP at 1 lb. per acre. OR M-Pede at 1 to 2% by volume.	14 day PHI. Must contact aphids to be effective. 0 day PHI.
Radishes:		
Aphids, flea beetles	Asana XL 0.66 EC at 5.8 to 9.6 oz. per acre. OR Baythroid 2EC at 1.6 to 2.8 fl. oz. per acre. OR Diazinon AG500 at 1 pt. per acre. OR Malathion 57EC at 1 qt. per acre. OR Sevin 50WP at 2 lb. or XLR Plus at 1 qt. per acre. OR M-Pede at 1 to 2% by volume.	Do not exceed 0.1 lb. a.i. per acre per season. 7 day PHI. Do not exceed 5 applications per season. Allow 7 days between applications. 0 day PHI. 14 day PHI. 7 day PHI. **Flea beetles only.** Will not control aphids. 7 day PHI. **Aphids only.** Must contact aphids to be effective. 0 day PHI.
Root maggots	*Apply as a furrow application at planting:* Lorsban 4E at 1 oz. per 1000 ft. of row, or 15G at 3.3 oz. per 1000 ft. of row. OR Diazinon 14G at 2.5 to 2.8 ox. per 1000 linear ft. of row.	 Apply 4E as a water-based (minimum 40 gal. water) drench, or the 15G in seed furrow with the seed at planting time. Do not exceed 5.5 pt. of 4E or 18.3 lb. of 15G per acre.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Turnips:		
Root maggots	*As a furrow application at time of planting:*	
	Diazinon AG500 at 1 pt. per acre. OR Lorsban 4E at 1.6 to 2.75 fl. oz. per 1000 ft. of row.	Apply as a drench spray over the row 30 days following planting. Will also help manage flea beetles. 14 day PHI.
Aphids, flea beetles	Ambush 2E at 3.2 to 6.4 fl. oz. per acre, or 25W at 3.2 to 6.4 oz. per acre.	**Illinois and Indiana only.** 1 day PHI.
	OR Dimethoate at 0.5 pt. per acre.	May not control flea beetles. 14 day PHI.
	OR Metasystox-R 2EC at 1.5 to 2 pt. per acre.	Do not apply more than 2 times per season. 7 day PHI, 21 day for turnip greens.
	OR Diazinon AG500 at 1 pt. per acre.	14 day PHI.
	OR M-Pede at 1 to 2% by volume. OR Align or Neemix according to label directions.	**Aphids only.** Must contact aphids to be effective. 0 day PHI. 0 day PHI.

SALAD AND GREENS CROPS

Spinach, Lettuce, Mustard, Collard, Endive, Parsley, Herbs, and Kale

Varieties

Salad Greens:

Collards:	Georgia, Vates. For blue-green leaves: Blue Max and Hi Crop.
Endive:	Full Heart Batavian, Green Curled Ruffoc.
Kale:	Blue Armor, Blue Knight.
Leaf Lettuce:	Tiara, Glossy Green, Green Wave, New Red Fire, Vulcan, Sierra.
Butterhead:	Buttercrunch, Esmeralda, Ermosa (for trial).
Head Lettuce:	Ithaca, Maverick (for trial), Montello (for trial).
Mustard:	Southern Giant, Green Wave.
Spinach:	Bloomsdale Long Standing (spring), Early Hybrid No. 7 (fall), Early Hybrid No. 10 (fall), Old Dominion (fall), Virginia Savoy (fall), Tyee, Melody, Decatur.

Herbs:

Cilantro:	Long Standing. Cilantro is a type of coriander grown for its aromatic leaves. Plant tends to bolt and must be planted early in the spring.
Fennel:	Marketed for its foliage as anise and for its edible leaf base as Florence or finocchio fennel. Plant has a strong licorice flavor and aroma.
Parsley:	Curly leaf-Moss Curled, Dark Moss Curled, Perfection. Flat leaf-Plain. Hamburg Parsley-has enlarged edible root marketed as a fresh product.
Sweet Basil:	Green foliage-Sweet basil, Mammoth, Italian Small leaf: Piccolo; Purple foliage-Dark Opal, Opal, Rubin. Will in part revert to green, caused by genetic instability. Lemon-Scented-Lemon basil, Sweet Dani Lemon Basil.

Spacing and Seeding

Fennel:	Rows 12 to 18 in. apart. Plants 6 to 8 in. apart in row. Transplant to the field early in the spring.
Spinach:	Rows 12 to 18 in. apart. Plants 4 to 6 per foot of row. Seed 12 to 20 lb. per acre.
Lettuce, Endive & Mustard:	Rows 12 to 15 in. apart. Plants 10 to 16 in. apart in row. Seed 1 to 2 lb. per acre.
Collard:	Rows 36 to 42 in. apart. Plants 18 to 24 in. apart in row. Seed 1 to 2 lb. per acre.
Sweet Basil:	Rows 15 to 36 in. apart. Plants 6 to 8 in. apart within rows.
Parsley:	Rows 15 in. apart. Plants 4 to 8 in. apart in row. Seed 30 lb. per acre. Presoaking seeds in water for 24 h., and then partially drying the seeds will enhance germination.

Except for collard, these crops can have a common between-row spacing for convenience in cultivating. Raised beds are recommended for the culinary herbs.

Fertilizing

Lime: To maintain soil pH of 6.5 to 6.8. Spinach is particularly sensitive to soil acidity.

Preplant: N, 60 lb. per acre; P_2O_5, 0 to 150 lb. per acre; K_2O, 0 to 200 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state.

Sidedress N: N, for soils with more than 3% organic matter and following soybeans, alfalfa, or a grass-legume hay crop, apply 30 lb. N per acre. For soils with less than 3% organic matter and the above rotation, apply 45 lb. N per acre. Following corn, rye, oats, wheat, or a vegetable crop, apply 60 lb. N per acre. Use a total of 90-120 lb. N per acre for culinary herbs. For herbs grown for seeds, such as coriander, fennel, and dill, use 60-90 lb. N acre.

Herb Weed Control

Plastic or an organic mulch is recommended. Most herbs are weak competitors to weeds, and herbicides are not available.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Spinach, Collard and Mustard Greens:	Plant only western-grown, hot-water, and fungicide treated seed.	
Damping off	Ridomil Gold EC at 1 to 2 pt. per acre applied pre-plant, to control damping-off. **(Spinach only).**	Apply preplant to the soil surface and incorporate to a depth of 2 in.
Downy mildew, white rust	Plant downy mildew resistant varieties.	
	Ridomil Gold EC at 1 pt. per acre applied pre-plant, and 1 to 2 pt. per acre after planting. **(Spinach only).**	Preplant soil application, with up to 2 additional soil applications after planting. Do not use mefanoxam after planting unless it was used at planting. 21 day PHI.
	OR	
	Aliette at 2 to 5 lb. per acre. Use 2 to 3 lb. rate when tank mixed with another fungicide registered for use on greens. Use 3 to 5 lb. rate when used alone. **(Not for use on mustard or collard.)**	Apply when conditions are favorable for disease and continue on a 7-21 day interval. Do not tank mix with copper fungicides. 12 hour REI. 3 day PHI.
	OR	
	Quadris at 6.2 to 15.4 oz. per acre for white rust and at 12.3 to 15.4 oz. per acre for downy mildew. **(Not labeled for mustard, collard).**	Avoid more than 4 applications of Quadris per season. Alternate with other registered products. Alternate with fungicides with different mode of action. No more than 2 sequential applications. For downy mildew, apply on a 5-7 day schedule. for all other diseases, begin before symptoms appear and repeat every 7-14 days.
	OR	
	Apply Actigard at 3/4 oz. per acre.	Use 7-10 day interval. 7 day PHI.
	OR	
	Basic copper sulfate at 3 pt. per acre.	Apply at 10 day intervals, beginning at the first sign of disease.
Lettuce:		
Seed rot, damping off	Treat seed with captan or thiram.	
	Ridomil Gold EC at 1 to 2 pt. per acre applied pre-plant to control damping-off caused by *Pythium* spp. **(Head lettuce only.)**	Apply pre-plant to the soil surface and incorporate to a depth of 2 in.
Bottom rot and drop	Avoid wet fields with disease history.	

DISEASES CONTROLLED	TREATMENT	COMMENTS
Lettuce: (cont.)		
Bottom rot and drop	Rovral at 1.0 to 1 1/3 lb. per acre of flowable (F) formulations, or 1.5 to 2 lb. per acre for dry formulations.	Apply at the 3-leaf stage. Repeat application in 10 days. A third application may be necessary if disease-favorable conditions persist. 14 day PHI.
	OR	
	Ronilan at 1 to 2 lb. per acre for dry formulations.	Apply within 2 days after seeding or 7-10 days after transplanting. Repeat in 14 days. A 3rd application may be necessary on direct-seeded lettuce if disease-favorable conditions persist. 20 day PHI.
Powdery mildew	Quadris at 12.3 to 15.4 oz. per acre (Spinach, Lettuce, Endive, and Parsley).	Alternate with a fungicide that has a different mode of action. Apply on a 5-7 day schedule.
	OR	
	Apply Microthiol Special at 3 to 10 lb. per acre (Collard, Kale and Mustard).	Apply at early leaf stage and repeat every 14 days or as needed. 24 hour REI.

Herbicides For Use on Greens Crops

Crop	Dacthal	Trifluralin	Kerb	Balan	Prefar	Poast	Fusilade	Spin-Aid	glyphosate	paraquat	Lorox
Kale	X	X			X	X			X		
Mustard	X	X			X	X			X		
Collards	X	X			X	X			X	X	
Turnip Greens	X										
Chicory		X							X		
Endive		X	X		X	X	X		X		
Lettuce			X	X	X	X			X	X	
Spinach						X		X	X		
Parsley					X	X			X		X
Florence Fennel					X	X			X		

Spinach, Lettuce, Mustard, Collard, Endive, Parsley Weed Control (cont.)

Herbicide*	Treatment**	Comments
PREEMERGENCE		
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply immediately after seeding. Use 50-mesh or larger screens. Not effective on muck or high organic soils.
Trifluralin (4 lb./gal.)	1 pt. per acre on light-colored soils (less than 2% organic matter), 1.5 pt. on darker colored soils, 2 lb. on light-colored soils to 4 lb. per acre on dark-colored soils with 4% or less organic matter.	Apply before planting, and incorporate immediately into soil by double discing, or with other equipment, to give thorough mixing 3 to 4 in. deep. Not effective on muck and other high organic soils.
Kerb 50WP	2 lb. on light-colored soils to 4 lb. on dark colored soils with 4% or less organic matter.	Apply before or after seeding and before weeds germinate. Must be incorporated or irrigated into soil. For endive and escarole, do not exceed 3 lb. per acre. Do not apply postemergence to leaf lettuce. RUP. 55 day PHI.
Balan 60DF	2 to 2.5 lb. per acre.	Apply before seeding, and incorporate 2-3 in. into soil immediately.
Prefar 4E	5 to 6 qt. per acre.	Apply before seeding, and incorporate lightly.
Lorox	1.5 to 2 lb. per acre.	Apply after planting before crop emerges. On muck soils, may apply 1 lb. per acre after parsley has 3 leaves. **East of Mississippi River only.** 30 day PHI.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Do not exceed 3 pt. per acre per season. 15 day PHI for leaf lettuce, spinach, endive, and parsley; 30 day PHI for mustard, collards, kale, fennel, and head lettuce.
Fusilade DX 2E	10 to 12 fl. oz. per acre.	Apply to actively growing grasses. Maximum of 3 pt. per acre. Include 1 qt. COC or 1 pt. nonionic surfactant per acre. 28 day PHI.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE (cont.)		
Spin-Aid 1.3E	3 to 6 pt. per acre in 11 to 22 gal. of water.	**Spinach grown for processing or seed only.** Apply to spinach past the 4 true leaf stage. Injury may occur if application precedes the 4 true leaf stage of spinach. Do not apply if spinach is under stress. Check label for weed control precautions. Does not control pigweed. 40 day PHI.
NON-SELECTIVE HERBICIDES		
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before or after planting but before crop emerges These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Some formulations allow spot spray application in lettuce - check label. Apply to emerged weeds before or after seeding but before crop emerges. RUP.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids, leafminers, mites	Admire 2F at 10 to 24 fl. oz. per acre. OR Provado 1.6F at 3.75 fl. oz. per acre. OR Agri-Mek 0.15EC at 8 to 16 fl. oz. per acre. OR	**Aphids and leafminers only.** Do not exceed 0.5 lb. a.i. Admire or Provado per acre per season. Collards, kale, kohlrabi, mustard greens, rape greens, lettuce, endive, or spinach. Do not exceed 18.75 fl. oz. Provado per acre per season. Allow 5 days between applications of Provado. 21 day PHI for Admire, 7 day PHI for Provado. **Leafminers only.** 7 day PHI.

Aphid Thresholds

Seedling - 2/plant
Established plants - 7/plant

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids, leafminers, mites (cont.) **Leafminer Thresholds** Seedling - 50% of plants infested Near Harvest - 5% of leaves	Thiodan, Endosulfan, or Phaser 3EC at 1 to 1.3 qt. or 50W at 1.5 to 2 lb. per acre. OR SpinTor 2 SC at 6 to 8 fl. oz. per acre. OR Metasystox-R 2S at 1.5 to 2 pt. per acre. OR Ammo 2.5EC at 2.5 to 5.0 fl. oz. per acre. OR Dimethoate at 0.75 pt. per acre. OR Trigard at 0.167 lb. per acre. OR Align or Neemix according to label directions. OR Dibrom 8E at 1 pt. per acre. OR M-Pede at 1 to 2% by volume. OR Orthene/Address 75S at 0.67 to 1.33 lb. per acre. OR Pounce 3.2EC at 4 to 8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre. OR Capture 2SC at 2.1 to 6.4 fl. oz. per acre.	7 day PHI for celery, 14 day PHI for lettuce, 21 day PHI for collards, kale, mustard greens, and spinach. Do not exceed 29 fl. oz. per acre. Observe resistance management restrictions. 1 day PHI. **Head lettuce only.** Do not exceed 3 applications per season. 21 day PHI. Do not exceed 0.6 lb. a.i. per acre per season. **Not for leaf lettuce.** 5 day PHI. **Do not use on parsley.** 14 day PHI for collard, endive, mustard greens, Swiss chard, spinach, turnip greens, and leaf lettuce; 7 day PHI for head lettuce. 7 day PHI. 0 day PHI. **Do not use on lettuce, mustard, endive, parsley, spinach, or turnip greens.** 1 day PHI for collard or kale. **Aphids only.** Must contact aphids to be effective. 0 day PHI. **Head lettuce only. Aphids only.** 21 day PHI. **Aphids and leafminers only.** Do not exceed 2 lb. a. i. per acre per season or 1 lb. a. i. per acre per season for spinach. 1 day PHI. **Aphids and mites only.** Do not exceed 32 fl. oz. per acre per season. 7 day PHI.
Flea beetles, leafhoppers	Warrior 1EC at 2.0 to 3.8 fl. oz. per acre. OR	Do not exceed 2.4 pts. per acre per season. **Lettuce only.** 1 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea beetles, leafhoppers (cont.) **Flea Beetle Threshold** Seedling plants >50% plants infested and defoliation > 30%	Admire 2F at 10 to 24 fl. oz. per acre. OR Provado 1.6F at 3.75 fl. oz. per acre. OR	Do not exceed 0.5 lb. a.i. Admire or Provado per acre per season. Collards, kale, kohlrabi, mustard greens, rape greens, lettuce, endive, or spinach. Do not exceed 18.75 fl. oz. Provado per acre per season. Allow 5 days between applications of Provado. 21 day PHI for Admire, 7 day PHI for Provado.
	Dimethoate at 0.75 pt. per acre. OR	**Do not use on parsley.** 14 day PHI for collard, endive, mustard greens, Swiss chard, spinach, turnip greens, and leaf lettuce; 7 day PHI for head lettuce.
	Malathion 57EC at 1.5 pt. per acre. OR	14 day PHI for leaf lettuce; 7 day PHI for head lettuce, endive, collard, mustard greens, and spinach; 21 day PHI for parsley.
	Sevin 50WP at 2 lb., 80SP at 1.25 lb., or XLR Plus at 1 qt. per acre. OR	14 day PHI.
	Capture 25C at 2.1 to 6.4 fl. oz. per acre. OR	Do not exceed 32 fl. oz. per acre per season. 7 day PHI.
	Pounce 3.2EC at 4 to 8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre. OR	**Aphids and leafminers only.** Do not exceed 2 lb. a. i. per acre per season or 1 lb. a. i. per acre per season for spinach. 1 day PHI.
	Fury 1.5EC or Mustang 1.5EW at 2.4 to 4.2 fl. oz. per acre. OR	**Head lettuce only.** 5 day PHI.
	Ammo 2.5EC at 2.5 to 5.0 fl. oz. per acre. OR	Do not apply more than 0.6 lb. a.i. per acre per season. **Not for leaf lettuce.** 5 day PHI.
	Methoxychlor 2EC at 1 to 2 pt. per acre. OR	**Do not apply to mustard or parsley.** 14 day PHI.
	Align or Neemix according to label directions.	0 day PHI.
Caterpillars, loopers	*Bacillus thuringiensis* (MVP, Javelin, Dipel, Cutlass, Biobit, Agree, Xentari, Lepinox, Ketch). OR	Follow label instructions for rates and use. 0 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Caterpillars, loopers (cont.)	Warrior 1EC at 1.9 to 3.8 fl. oz. per acre. OR	Do not exceed 2.4 pts. per acre per season. **Lettuce only.** 1 day PHI.
	Capture 25C at 2.1 to 6.4 fl. oz. per acre. OR	Do not exceed 32 fl. oz. per acre per season. 7 day PHI.
Threshold 5% of plants infested	Lannate 90 SP at 0.5 to 1 lb. per acre, or LV at 1.5 to 3 pt. per acre. OR	Should control aphids. 7 day PHI for lettuce at 0.25 to 0.5 lb. rate, or 10 day PHI for 1 lb. rate; 7 day PHI for spinach; 10 day PHI for collard, Chinese cabbage, endive, kale, parsley, turnip, and mustard.
	Ammo 2.5EC at 2.5 to 5.0 fl. oz. per acre. OR	Do not exceed 0.6 lb. a.i. per acre per season. **Not for leaf lettuce.** 5 day PHI.
	Larvin 3.2 AF at 16 to 30 fl. oz. per acre. OR	Do not exceed 60 fl. oz. per acre per season. **Not for mustard or collard.** 14 day PHI.
	Ambush 2EC at 6.4 to 12.8 fl. oz., or 25WP at 6.4 to 12.8 oz. per acre. OR Pounce 3.2EC at 2 to 8 fl. oz. or 25WP at 3.2 to 12.8 oz. per acre. OR	Do exceed 2 lb. a.i. per acre of Ambush or Pounce per season or 1 lb. a.i. per acre per season for spinach. See label for appropriate crops. 1 day PHI.
	Fury 1.5EC or Mustang 1.5W at 2.4 to 4.2 fl. oz. per acre. OR	**Head lettuce only.** 5 day PHI.
	Scout X-Tra 0.9EC at 2.28 to 2.84 fl. oz. per acre. OR	**Head and leaf lettuce only.** Do not exceed 27 fl. oz. per acre per season. 3 day PHI.
	SpinTor 2 SC at 4 to 8 fl. oz. per acre. OR	Do not exceed 29 fl. oz. per acre per season. 1 day PHI.
	Proclaim 5WDG at 2.4 to 4.8 oz. per acre. OR	**Head lettuce only.** No more than 2 sequential applications. Allow 7 days between applications. 7 day PHI.
	Asana XL at 5.8 to 9.6 fl. oz. per acre. OR	**Collard and mustard greens only.** 7 day PHI.
	Avaunt 30WDG at 2.5 to 3.5 oz. per acre.	**Head and leaf lettuce only.** Do not exceed 14 oz. per acre per season. 3 day PHI.

SNAP BEAN VARIETIES	Use	Pod Color	Seed Color	Comments
Bush Snap Bean Varieties-Green Pod				
Benchmark	market	med.-dark green	white	excellent quality
Bronco	market	dark green	white	excellent quality, mechanical harvest
Daytona	market	med. green	white	
Envy	processing			
Evergreen	processing			
Flo	processing			
Hialeah	market	green	white	excellent quality
Hystyle	market, processing	dark green	white	mechanical harvest
Labrador	market, processing	dark green	white	
Opus	market	med.-light green	white	rust tolerant
Rushmore	market	med. green	brown	early
Strike	market	med.-light green	white	mechanical harvest
Tema	market	med.-dark green	brown	
Venture	market, processing	dark green	white	early
Yellow Pod				
Eureka	market	yellow	white	
Gold Mine	market	yellow	white	susceptible to brown spot
Gold Rush	market, processing	yellow	white	susceptible to brown spot
Kinghorn Wax	market	yellow	white	excellent quality
Klondyke	market	yellow	white	mechanical harvest
Nugget	market, processing	yellow	white	

LIMA BEAN VARIETIES	Use	Seed Color	Comments
Henderson Bush	market & home	white	Bush, very early, small seed, high yield
Fordhook 242	market & home	white	Bush, midseason, med. size, variable yield
Bridgeton	processing	greenish	Bush, late, medium size
King of the Garden	home garden	greenish-white	Pole, midseason to late, large seed

SPACING AND SEEDING

Row 18 to 36 in. apart. Larger inter-row spacing helps to limit white mold development.
5 to 7 seeds per foot of row. Seed 70 to 100 lb. per acre.

IRRIGATION

If soil is dry at planting time, irrigate to ensure uniform seed germination. Snap beans must be irrigated in dry seasons, especially during blooming and pod development. They need 1 to 1.5 in. of water every 4-5 days.

FERTILIZING

Lime: To maintain a soil pH of 6.0 to 6.8.

Preplant: N, for soils with more than 3% organic matter and following soybeans, alfalfa, or a grass-legume hay crop, no N is needed. For soils with less than 3% organic matter and the above rotation, apply 30 lb. N per acre. For snap beans

following corn, rye, oats, wheat, or a vegetable crop, apply 40 to 60 lb. N per acre. P_2O_5, 0 to 75 lb. per acre; K_2O, 0 to 100 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state.

A band placement (2 in. to the side and 2 in. below the seed) of a starter fertilizer (12-48-0, lb. of N, P_2O_5, and K_20) at seeding has proven beneficial. No K is included in the starter fertilizer because potassium chloride (KCl) can reduce snap bean germination through salt injury. Beans are sensitive to Zn deficiency and if the soil Zn test is below 0.7 ppm, broadcast and incorporate prior to planting 5 lb. Zn per acre. Or include 1 lb. Zn per acre in the fertilizer band at planting.

Sidedress N: None needed.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Dry beans: rust, anthracnose	Follow 2-3 year rotation schedules.	
	Rust resistant varieties are available.	
	Several chlorothalonil formulations are labeled such as Agronil 720, Bravo 500, Bravo Ultrex, Bravo weather stik, Echo 720 and Equus DF. Rates vary per formulation.	Begin applications during early bloom or when disease threatens. 48 hour REI. 14 day PHI.
	OR	
	Anthracnose only: Topsin 70W.	Use 1.5 to 2 lb. per acre if applied once at 50% to 70% full bloom. Apply twice if first application is at 10% to 30% full bloom and second application is 4 to 7 days later (peak bloom). 14 day PHI.
	OR	
	Apply Manex at 1.2 to 1.6 qt. per acre, Maneb 75DF or Maneb 80WP 1.5 to 2.0 lb. per acre.	Spray on a 7 day interval. 30 day PHI.
Snap beans: rust	Follow 2-3 year rotation schedules.	
	Rust resistant varieties are available.	
	Several chlorothalonil formulations labeled such as Agronil 720, Bravo 500, Bravo Ultrex, Bravo Weather Stik, Echo 720 and Equus DF. Rates vary per formulation.	48 hour REI. 7 day PHI.
	OR	
	Nova 40W at 4 to 5 oz. per acre.	30 day plant back restriction. 24 hour REI. 0 PHI.
	Plant only western-grown, certified seed.	

DISEASES CONTROLLED	TREATMENT**	COMMENTS
Bacterial blights Brown spot Halo blight Common blight	Follow 2-3 year crop rotation schedules. Field applications of fixed copper fungicides. Application rates vary widely with product and formulation.	Repeat at 7-10 day intervals. Copper sprays will slow the spread of bacterial blights in the field. **Do not use copper on fresh market lima bean.**
White mold and Gray mold	Avoid wet fields with a history of white mold.	
	Benlate SP 24 to 32 oz. per acre. OR	Apply from 10% bloom to 7 days after bloom. Repeat after 7-10 days. Observe restrictions on feeding of forage. 14 day PHI for dry or snap beans. 28 day PHI for lima beans.
	Topsin M WSB at 1.5 to 2 lb. per acre depending on application method. OR	Apply once at 50% to 70% full bloom, or apply twice, the first at 10% to 30% full bloom and a second application at peak bloom. Observe restrictions on feeding of forage. 14 day PHI for dry or snap beans. 28 day PHI for lima beans.
	Rovral 75WG at 1.0 to 1.33 lb. per acre for dry formulations or 1.5 to 2 pt. per acre for flowable formulations. OR	Apply at first bloom, when 10% of the plants have one open bloom, and again at peak bloom. Observe restrictions on feeding of forage. Do not treat after full bloom. 24 hour REI.
	Gray mold only: Several chlorothalonil formulations are labeled such as Agronil 270, Bravo 500, Bravo Ultrex, Bravo weather stik, Echo 720 and Equus DF. Rates vary per formulation.	Apply at weekly intervals as needed. 7 day PHI.
Seedling diseases and root rots	Plant only western-grown certified seed in warm well-drained seed beds. Treat seed with Apron 25XL-LS plus captan or thiram.	Fungicides containing mefanoxam (Ridomil Gold) may help control early season seedling diseases caused by Pythium. Ridomil PC GR or PCNB may be used to help control Rhizoctonia.
	Apply Ridomil Gold EC at 0.5 to 1 pt. per acre at planting, or Ridomil PC 11G at 0.75 lb. per 1000 ft. of row at planting.	Ridomil 48 hr. REI.
Soybean Cyst Nematode (SCN)	Rotate at least 2-3 years with corn, small grains, alfalfa, or other non-host crop.	Do not include soybeans in the rotation.

DISEASES CONTROLLED	TREATMENT**	COMMENTS
Mosaic Virus Diseases	Plant varieties with resistance to common mosaic, NY15 strain of common mosaic, and bean yellow mosaic.	Bush Blue Lake 274, Provider, Tendercrop, Cherokee, Goldcup.

HERBICIDE	TREATMENT	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. on light soils (less than 1.5% organic matter), 14 lb. on darker soils in at least 50 gal. water per acre.	Apply immediately after planting. 50-mesh or larger screens. Not effective on muck soils and other high organic soils.
Dual Magnum, II Magnum	1 to 2 pt. per acre. Use low rate on coarse soils.	**Not on muck soils.** Apply and incorporate before seeding or apply after seeding but before emergence. Can be tank mixed preplant with Eptam or Treflan.
Trifluralin (4 lb./gal.)	1 pt. per acre on light-colored soils (less than 2% organic matter), 1.5 pt. on darker colored soils.	Apply before planting, and incorporate immediately by double discing or with other equipment for thorough mixing 3 to 4 in. deep. Not effective on muck soil and other high organic soils.
Eptam 7E or 10G	3.5 pt. per acre of 7E, or 30 lb. per acre of 10G.	Apply before planting, and incorporate immediately into soil by double discing or with other equipment to give thorough mixing 3 to 4 in. deep. May also be applied as directed spray at last culivation. **Not on lima beans.** Check label for sensitive dry bean varieties.
Prowl 3.3E, Pendimax 3.3E	1.2 to 3.6 pt. per acre.	Apply preplant, and incorporate 1 to 2 in. deep.
Lasso 4E	2.5 to 3 qt. per acre.	Not for snap beans or for dry beans east of the Mississippi except red kidneys in IL, IN, and WI. Apply before planting, and incorporate. RUP.
Sonalan	1.5 to 4.5 pt. per acre.	**Dry beans only.** Incorporate 2 to 3 inches deep within 2 days of application and before planting. Use higher rates to suppress eastern black nightshade. Not on peat or muck soils.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE	TREATMENT	COMMENT
PREEMERGENCE (cont.)		
Pursuit Plus	20 to 30 fl. oz. per acre.	**Not for snap beans.** Incorporate before planting. Use only in IL, IA, MN south of highway 210. Apply before June 30. Do not use on "Domino" black turtle beans. 30 day PHI for lima beans, 60 day PHI for dry beans.
Frontier 6.0, Outlook 6.0	1.25 to 2 pt. Frontier or 10 to 21 fl. oz. Outlook per acre. Use lower rate on coarse soils low in organic matter.	**Dry beans only.** Apply before planting and incorporate, or after planting before 3 leaf stage.70 day PHI.
Command 3ME	0.4 to 0.67 pt. per acre.	Apply before seeding or after seeding before crop emerges. 45 day PHI.
POSTEMERGENCE		
Reflex 2L	0.75 pt. per acre. Add 0.5 to 1 pt. nonionic surfactant or 1 to 2 pt. COC per 25 gal. spray solution.	**Dry beans only.** Only in special counties in Minnesota. Apply before bloom. 3 day PHI.
Basagran 4L	1.5 to 2 pt.	Do not apply until first trifoliate leaf is fully expanded. Do not exceed 2 qt. per acre per year. 30 day PHI.
Poast 1.5E	1 to 1.5 pt. plus 1 qt. COC per acre.	Apply to actively growing grass. Do not exceed 4.0 pt. per acre per season. 15 day PHI for succulent beans. 30 day PHI for dry beans.
Select 2E	6 to 8 oz. per acre plus 4 qts. COC per 100 gallons spray solution.	**Dry beans only.** Apply to actively growing grass. Do not exceed 1 qt. per acre per year. 30 day PHI.
Assure II 0.88E	6 to 10 fl. oz. plus 1 qt. COC per acre.	Apply to actively growing grass. 30 day PHI for dry beans, 15 day PHI for snap beans.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before or after seeding but before crop emergence.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray applications - check label. Apply to emerged weeds before crop emerges or after harvest in fall. These rates are for annual weeds at application volumes of 10 to 40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Seed corn maggot	Plant seed that has been treated with a product containing diazinon or a lindane-diazinon combination.	Flies are attracted to rotting organic material and freshly plowed soil. Plow winter cover crop under early in the spring and thoroughly cover. Handle seeds carefully to prevent cracking.
	Thimet 20G at 4.5 to 7 oz. per 1000 linear feet of any row spacing (minimum 30-in. spacing).	Apply granules in a band over the row at planting time. Do not place granules in direct contact with the seed. Do not feed bean foliage. 60 day PHI.
Mexican bean beetle, leafhoppers, bean leaf beetle, aphids	Di-Syston 15G at 6 to 12 oz. per 1000 feet row (for any row spacing) or 6.7 to 13.3 lb. per acre (30-inch row spacing).	Place granules on sides of seed furrow at planting. Do not apply directly on the seed or more than once per season. Do not use treated vines for feed. 60 day PHI.
	OR	
	Orthene/Address 75S at 0.67 to 1.33 lb. per acre. Should control corn borer at high rate.	Do not use treated vines as feed. 14 day PHI for snap and dry beans, 0 days for lima beans.
	OR	
	Capture 2 EC at 1.6 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.2 lb. a.i. per acre per season. Do not feed or graze livestock on treated vines. 21 day PHI for dry beans, 3 day PHI for snap beans or lima beans.
	OR	
	Sevin XLR Plus at 1 qt. per acre. Use 1.5 qt. per acre for Mexican bean beetle.	**Not for aphids.** 3 day PHI for fresh beans, 21 day PHI for dry beans.
	OR	
	Lannate LV at 0.75 to 3 pt. per acre.	Do not feed hay to livestock for 7 days. **Not for bean leaf beetle.** 1 day PHI for succulent beans at 0.75 to 1.5 pts., 3 day PHI at high rate, 14 day PHI for dry beans.
	OR	
	Methoxychlor 2EC at 2 to 6 qts. per acre.	**Not for aphids.** 3 day PHI.
	OR	
	Thiodan 50WP at 1 lb. or 3EC at 0.67 to 1.33 qt. per acre.	Apply before leaves curl. Do not exceed 3 applications per season. Do not feed treated threshings to livestock or allow to graze in treated fields. **Not for lima beans.** 3 day PHI.
	OR	

Potato Leafhopper Thresholds

Seedling - 0.5/sweep or 2 per row foot
3rd trifoliate - 1/sweep or
Budstage - 5 per row foot

Bean Leaf Beetle Threshold

1 beetle per foot of row

Mexican Bean Beetle Threshold

0.5 beetles/plant

INSECTS CONTROLLED	TREATMENT	COMMENTS
Mexican bean beetle, leafhoppers, bean leaf beetle, aphids (cont.)	Metasystox 2RS at 2 pt. per acre.	Do not exceed 3 applications per season. Do not graze or feed within 21 days of application. Should also control mites. **Not for dry bean.** 21 day PHI.
	OR	
	Dimethoate at 0.75 to 1.5 pt. per acre.	Do not feed treated vines to livestock. **Aphids and leafhoppers only.** 0 day PHI.
	OR	
	Provado 1.6F at 3.5 fl. oz. per acre.	**Aphids can leafhoppers only.** Do not exceed 10.5 fl. oz. per acre per season. 7 day PHI.
	OR	
	M-Pede at 1 to 2% by volume.	**Aphids only.** Must contact aphids to be effective. 0 day PHI.
European corn borer	Orthene/Address 75S at 1.3 lb. per acre.	Beginning at bloom, repeat treatment at 7-day intervals as long as moth flight above threshold continues or until beans are ready to be harvested. 14 day PHI, 0 day PHI for lima bean.
	OR	
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3 day PHI.
	OR	
	Penncap-M at 2 to 4 pt. per acre.	**Dry bean only.** 15 day PHI.
	OR	
	Lannate LV at 3 pt. or 90SP at 1 lb. per acre.	3 day PHI, 14 day PHI for dry bean.
	OR	
	SpinTor 25C at 4 to 6 fl. oz. per acre.	3 day PHI. Do not exceed 29 fl. oz. per acre per season or 12 fl. oz. per acre for dry beans.
Corn earworm	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 38.4 fl. oz. per acre per season. Do not feed vines to livestock. 3 day PHI.
	OR	
	Sevin XLR Plus at 1.5 pt. per acre.	3 day PHI for fresh beans, 21 day PHI for dry beans.
	OR	
	Lannate LV at 3 pt. or 90SP at 1 lb. per acre.	3 day PHI, 14 day PHI for dry bean.
	OR	

INSECTS CONTROLLED	TREATMENT	COMMENTS
Corn earworm (cont.)	SpinTor 25C at 4 to 6 fl. oz. per acre.	3 day PHI. Do not exceed 29 fl. oz. per acre per season or 12 fl. oz. per acre for dry beans.
Mites	Capture 2EC at 5.8 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3 day PHI.
	Kelthane MF at 0.75 to 1 pt. per acre. OR	Apply at first sign of mites. Repeat as necessary. Do not feed treated vines to meat or dairy animals. 7 day PHI.
	Dimethoate at 0.75 to 1.5 pt. per acre. OR	Do not feed to livestock. Do not apply during bloom. 0 day PHI.
	Lannate LV at 3 pt. or 90SP at 1 lb. per acre.	3 day PHI, 14 day PHI for dry bean.

Varieties

Summer Squash	**Zucchini:**	Revenue, Dividend, Spineless Beauty, Jaguar, Puma, Independence II.
	Yellow Straightneck:	Lemondrop L, Multipick, General Patton, Monet, Liberator III.
	Yellow Crookneck:	Dixie, Prelude.
	Golden Zucchini:	Goldfinger, Golden Delight.
	Middle Eastern:	Lita, Bonita.
Winter Squash	**Acorn:**	Table Ace, Seneca Autumn Queen, Taybelle, Table Queen, Mesa Queen.
	Butternut:	Butternut Supreme, Nicklow's Delight, Zenith, Waltham, Early Butternut, Butterboy.
	Buttercup:	Buttercup Burgess, Autumn Cup.
	Hubbard:	Blue Hubbard.
	Spaghetti:	Vegetable Spaghetti, Tivoli.
Pumpkin	**Miniature:**	Jack Be Little, Baby Boo (white), Mini-Jack, Munchkin.
	For trial:	Sweetie Pie, We-B-Little.
	Small size:	Baby Bear, Oz, Mystic Plus, Hybrid Pam, Small Sugar, Spookie.
	For Trial:	Spooktacular.
	Medium size:	Wizard, Rocket, Tom Fox, Gold Fever, Racer.
	For trial:	Howdy Doody, Merlin (PMT), Jack of all Trades, Gold Standard.
	Large size:	Appalachian, Connecticut Field, Gold Rush, Howden, Biggie, Magic Lantern (PMT), ProGold 500.
	For trial:	Autumn King, Ol' Zeb's, Trax Field, Trojan, Gold Medal.
	Very large size:	Atlantic Giant, Big Max, Big Moon, Prize Winner.
	Specialty types:	Buckskin, Fairytale, Jarradale, Rouge Vif D'Etampes (Cinderella).
	Hull-less/naked seed:	Triple Treat (medium size, can also be used as a Halloween type), Snack Jack.

PMT = Tolerant to powdery mildew

Spacing and Seeding

Bush Types: Rows 4 to 6 ft. apart. Plants 18 to 24 in. apart in row. Seed: 4 to 6 lb. per acre.

Vining Types: Rows 4 to 6 ft. apart. Plants 2 to 5 ft. apart in row. Seed: 2 to 3 lb. per acre.

Fertilizing

Lime: To maintain a soil pH of 6.0 to 6.8.

Preplant: N, 50 lb. per acre; P_2O_5, 0 to 150 lb. per acre; K_2O, 0 to 200 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. For summer squash transplants, starter solution at the rate of 1 cup (8 oz.) per plant is recommended. See p. 3 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.

Sidedress N: For soils with more than 3% organic matter and following soybeans, alfalfa, or a grass-legume hay crop, no N is needed. For soils with less than 3% organic matter and the above rotation or a rotation of corn, rye, oats, wheat, or a vegetable crop, apply 30-40 lb. N per acre when the vines begin to run. For sandy soils, the preplant N application can be replaced by an early sidedressing of 40 lb. N per acre when the plants show the first set of true leaves. Then, apply the second sidedressing of 45 lb. N per acre at onset of rapid vining.

For summer squash grown from transplants on plastic mulch, the N losses from leaching are greatly reduced. For this culture system, apply 50 lb. N per acre broadcast preplant over the row just prior to laying the plastic. Sidedress 30 lb. N per acre on either side of the plastic at vining when the plant roots have reached the edge of the plastic. If you are using trickle irrigation, then apply the 50 lb. N per acre preplant, and apply 0.5 to 1 lb. N per acre daily or 3 to 6 lb. N on a weekly basis through the trickle system.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Bacterial leaf and fruit spot	2 year crop rotation. Avoid fields with a history of bacterial leaf and fruit spot. We suggest 3-4 applications of copper applied at 10 day intervals beginning when fruit are approximately 4" in diameter.	Do not save seed for planting next year. All squashes and pumpkins appear to be susceptible. It is important to use uncontaminated seed.
Bacterial wilt	Use systemic and contact insecticides for cucumber beetle control.	Consult section on bacterial wilt control for cucumbers and melons.
Black rot	3-4 year crop rotation.	Rotation with non-cucurbit crops will significantly reduce the threat of blackrot in future melon crops.
	Bravo 500 at 2.75 to 4.25 pt. per acre. Most other chlorothalonil formulations are 2 to 3 pt. per acre for flowable and 1.8 to 2.7 lb. for dry.	Apply protective fungicides beginning with first vine touch within rows or at first sign of disease. Use 7-10 day application interval.
	OR	
	Quadris 2.08EC at 11.0 to 15.4 fl. oz. per acre.	No more than 2 sequential applications. 7-14 day application schedule. 4 hour REI. 1 day PHI.
	Summer squash only: Dithane M45 or DF or Penncozeb 75DF at 2 to 3 lb. per acre, or Dithane F45 at 1.6 to 2.4 qt. per acre.	24 hour REI. 5 day PHI.
Downy mildew	Ridomil Gold Bravo at 2.0 lb. per acre. 14 day spray interval.	48 hour REI. 0 day PHI.
	OR	
	Bravo 500 at 2.75 to 4.25 pt. per acre, Bravo Ultrex at 1.8 to 2.7 lb. per acre, Bravo WS at 2 to 3 pt. per acre, or Terranil of Echo at labeled rates.	Apply protective fungicides beginning with first vine touch within rows or at first sign of disease. Use 7-14 day application interval. 0 day PHI.
	OR	
	Manex at 1.2 to 1.6 qt. per acre, or Maneb 75DF or 80WP at 1.5 to 2 lb. per acre.	24 hour REI. 5 day PHI.
	OR	
	Fixed copper fungicides at 7-10 day intervals.	
	OR	
	Aliette at 2 to 5 lb. per acre. Use 2 to 3 lb. rate when tank mixed with another fungicide labeled for downy mildew (other than copper). Otherwise use the 3 to 5 lb. rate.	12 hours PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Downy mildew (cont.)	Quadris 2.08EC at 11.09 to 15.4 fl. oz. per acre. OR	Alternate with other fungicides. 5-7 day spray interval. 4 hour REI. 1 day PHI.
	Flint at 4.0 oz. per acre. OR	Use 7-14 day interval. Do not exceed two consecutive applications. Do not Rotate with Quadris. 12 hour REI. 0 day PHI.
	For summer squash only: Dithane M45 or DF or Penncozeb at 2 to 3 lb. per acre, or Dithane F45 at 1.6 to 2.4 qt. per acre.	24 hour REI. 5 day PHI.
Microdochium blight (Pumpkin)	3 to 4 year crop rotation. Currently no fungicides are labeled for use on Microdochium blight. Management activities that control black rot should also control Microdochium blight.	Rotation with non-cucurbit crops.
Powdery mildew	Resistant varieties.	Partially resistant varieties are available.
	Benlate at 8 oz. per acre. 10-14 day spray interval. OR Nova 40 W at 2.5 to 5 oz. per acre. OR Topsin 85WDG at 4 oz. per acre. 10-14 day spray interval. OR	Initial applications should be made when earliest pumpkins are still green and are more than 1/2 their estimated full size (mid-late July). Repeat applications at 2 week intervals through early September. Benlate 24 hour REI, 1 day PHI. Flint 12 hour REI, 1 day PHI. Nova, 24 hour REI, 0 day PHI. Quadris 4 hour REI, 0 day PHI.
	Quadris 2.08EC at 11.0 to 15.4 fl. oz. per acre. OR	Alternate with other fungicides. 5-7 day spray interval. 4 hour REI. 0 day PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Powdery mildew (cont.)	Flint at 1.5 to 2.0 oz. per acre.	Use 7-14 day interval. Do not exceed two consecutive applications. Do not Rotate with Quadris. 12 hour REI. 0 day PHI. The fungi which cause powdery mildew may become resistant to these systemic fungicides unless precautions are taken. Always alternate between fungicides with different modes of action. Flint and Quadris have the same mode of action and must never be applied back to back. Similarly, Benlate and Topsin have the same mode of action. Nova has yet a different mode of action.
Phytophthora root and fruit rot	Avoid fields with a history of the disease on cucurbits, peppers, or tomatoes. **Summer squash only:** Dithane M45 or DF or Penncozeb 75DF at 2 to 3 lb. per acre, or Dithane F45 at 1.6 to 2.4 qt. per acre.	Turban squash is extremely susceptible.
Pumpkin viruses	Pumpkin viruses are best controlled by planting early so that fruit are set before virus diseases become apparent. For example, growers in southwestern Indiana should plant by June 20.	Although most pumpkin viruses are spread by aphids, controlling aphids with insecticides is not effective for virus disease control in late season cucurbits.

HERBICIDE	TREATMENT	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. on light soils (less than 1.5% organic matter), 15 lb. on other soils.	Not effective on soils with greater than 5% organic matter. Apply to soil when plants have 4 to 5 true leaves. **Squash only.**
Prefar 4E	5 qt. per acre on light-colored, sandy soils (less than 1% organic matter), 6 qt. on other soils.	Apply before seeding or transplanting, and incorporate into soil to a depth of 1 to 2 in. May be applied to the soil surface immediately after seeding in freshly worked soil if sprinkler-irrigated within 24 hours. Do not apply after transplanting.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE	TREATMENT	COMMENTS
PREEMERGENCE (cont.)		
Command 3ME	0.67 to 1.33 pt. per acre for summer squash; up to 2 pt. for winter squash.	Apply before seeding or transplanting. Do not apply to soil that will be covered with plastic mulch. See label for sensitive varieties. **Not for use on jack-o-lantern pumpkins.** 45 day PHI.
Curbit 3EC	3 to 4 pt. per acre.	Apply Curbit to the soil surface within 2 days after seeding of pumpkins, winter and summer squash. Do not incorporate Curbit prior to planting because crop loss will occur. See label for other restrictions.
POSTEMERGENCE		
Poast 1.5E	1 to 1.5 pt. per acre plus 1 qt. COC per acre.	Apply to actively growing grass. Maximum of 3 pt. per acre per year. 14 day PHI.
Select 2EC	6 to 16 fl. oz. for annual grasses; 8 to 16 fl. oz. for perennial grasses; plus 1 qt. COC per 25 gal. spray solution (1% v/v).	Apply to actively growing grasses. Wait at least 14 days between applications. Maximum 32 fl. oz. per season. 14 day PHI.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before or after seeding, but before crop emerges. Some formulations permit postemergence directed spray - check label. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to weeds* before planting. Wait 3 days to plant. These rates are for annual weeds at application volumes of 10 to 40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cucumber beetles	*Apply at planting (either at seeding or time of transplanting).*	
	Admire 2F at 16 to 24 fl. oz. per acre.	Apply pre-plant in a 2 inch or smaller band, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 24 fl. oz. per acre per season. 21 day PHI.
	Furadan 4F at 2.4 fl. oz. per 1000 linear feet of row.	Apply directly into seed furrow or as a 7-inch band over the row. This application is for seeding protection and beetle control after seedlings emerge or as transplants become established. **Indiana and Illinois only.**
Cucumber beetles, squash vine borer, squash bug (cont.)	*Use when insects exceed threshold.*	Apply insecticides when squash bug eggs begin to hatch. Larger nymphs and adults are very difficult to control.
	Pounce 3.2EC at 4 to 8 oz. or 25WP at 6.4 to 12.8 oz. per acre.	Apply in minimum of 4 gal. finished spray per acre by air or 20 gal. finished spray per acre by ground equipment. Do not exceed 1.6 lb. a.i. per acre per season. Use high rate for squash bugs. 0 day PHI.
	OR	
	Ambush 2E at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre.	
	OR	
	Capture 2EC at 2.6 to 6.4 fl. oz. per acre.	Do not exceed 19.2 fl. oz. per acre per season.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.25 lb. a.i. per acre per season. 3 day PHI.
	OR	
	Lannate LV at 1.5 to 3 pt. per acre.	**Summer squash only.** Will also control aphids. PHI: 1.5 pt. - 1 day, more than 1.5 pt. - 3 days.
	OR	
	Thiodan, Endosulfan, or Phaser 50WP at 2 lb. per acre.	2 day PHI.
	OR	
	Sevin 50WP at 2 lb. per acre, or Sevin XLR Plus at 1 qt. per acre.	**Cucumber beetles only.** Apply as soon as plants emerge, and repeat as needed. 3 day PHI.
	OR	
	Methoxychlor 3EC at 2 to 6 qts. per acre.	**Cucumber beetles only.** 7 day PHI.
	OR	
	Sabadilla according to label directions.	1 day PHI.

Thresholds

Cucumber Beetle
5 beetles/plant

Squash Bug
1 egg mass/plant through flowering

INSECTS CONTROLLED	TREATMENT	COMMENTS
Aphids, leafhoppers		Virus diseases carried by aphids cannot be prevented by killing aphids with insecticides.
	Admire 2F at 16 to 24 fl. oz. per acre.	Apply pre-plant in a 2 inch or smaller band, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 24 fl. oz. per acre per season. 21 day PHI.
	Capture 2EC at 2.6 to 6.4 fl. oz. per acre. OR	Do not exceed 19.2 fl. oz. per acre per season. 3 day PHI.
	Pounce 3.2EC at 4 to 8 oz. or 25WP at 6.4 to 12.8 oz. per acre. OR	Do not exceed 1.6 lb. a.i. per acre per season. Minimum volume of 20 gal. per acre on ground, or 4 gal. per acre by air. 0day PHI.
	Diazinon 50WP at 1 to 1.5 lb. or AG500 at 1 to 1.5 pt. per acre. OR	**Not for pumpkins.** One application per season. 3 day PHI for winter squash, 7 day for summer squash.
	Fulfill 50 WG at 2.75 oz. per acre. OR	Do not exceed 5.5 oz. per acre per season. 14 day PHI.
	Metasystox-R 2EC at 1.5 to 2 pt. per acre. OR	**Aphids only.** One application per season. 3 day PHI for summer squash, 14 day PHI for winter squash and pumpkin.
	Lannate LV at 1.5 to 3 pt. per acre. OR	**Summer squash only.** PHI: 1.5 pt. - 1 day, more than 1.5 pt. - 3 days.
	Malathion 57EC at 2 pt. per acre. OR	Ground application only. **Not for pumpkin.** 1 day PHI.
	M-Pede at 1 to 2% by volume. OR	**Aphids only.** Must contact aphids to be effective. 0 day PHI.
	Actara 25 WDG at 2-3 oz. per acre.	**Aphids only.** Do not exceed 8 oz. per acre per season. 0 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Mites	Capture 2EC at 5.12 to 6.4 fl. oz. per acre.	Do not exceed 19.2 fl. oz. per acre per season. 3 day PHI.
	OR	
	Kelthane 35WP at 1 to 1.67 lb. per acre.	2 day PHI.
	OR	
	Agri Mek 0.15EC at 8 to 16 fl. oz. per acre.	Do not exceed 48 fl. oz. per acre per season. 7 day PHI.
Whiteflies	Admire 2F at 16 to 24 fl. oz. per acre.	Apply pre-plant in a 2 inch or smaller band, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 24 fl. oz. per acre per season. 21 day PHI.
	Capture 2EC at 5.12 to 6.4 fl. oz. per acre.	Do not exceed 19.2 fl. oz. per acre per season. 3 day PHI.
	OR	
	Align or Neemix according to label directions.	0 day PHI.
	OR	
	M-Pede at 1 to 2% by volume.	Must contact whiteflies to be effective.
	OR	0 day PHI.
	Actara 25 WDG at 3 to 4 oz. per acre.	Do not exceed 8 oz. per acre per season. 0 day PHI.

Sugar-Enhanced (se) and Shrunken (sh_2) or Supersweet Sweet Corns

There are three major types of sweet corn. These types vary in their sweetness, keeping quality after harvest, and cold soil vigor. Each type is available in yellow, bi-color, and white varieties.

Standard (su) sweet corn often does better than the other types in cold soils. Typically, it is not as sweet as the other types, and the sugar content declines rapidly after harvest. Standard sweet corn is grown today primarily for processing, for early fresh market sweet corn, and for specialized markets.

Sugar-enhanced (se) sweet corn has a higher sugar content and is more tender than standard sweet corn. These types are grown primarily for direct retail sales and local wholesale markets.

Supersweet (shrunken-2 or sh_2) sweet corn has a higher sugar content than standard sweet corn. The sugar content does not decline rapidly after picking, so the corn remains sweet for several days after harvest. These types are grown primarily for wholesale shipping markets and local fresh markets. The seed of these varieties is smaller and lighter than seed of normal corn and typically does not do well in cold soil. For best results, do not plant until soil temperature reaches 60°F. Uneven stands and nonuniform emergence are relatively common.

Isolation Requirements

All sweet corn types should be isolated from field corn pollen by a distance of 250 ft. or by a tasseling date of 14 days.

Supersweet (sh_2) varieties must be isolated from standard (su) and sugar-enhanced (se) types by a distance of 250 ft. or by a tasseling date of 14 days. If not isolated, kernels of both varieties will be starchy instead of sweet.

It is not essential to isolate sugar-enhanced (se) sweet corn from standard sweet corn: cross-pollination will not result in starchy kernels. However, isolation will permit the full expression of the sugar-enhanced traits.

To maintain purity of color, white corn should be isolated from yellow or bi-color corn. Pollen from yellow or bi-color corn will cause some yellow kernels in white varieties. Pollen from yellow corn will lead to extra yellow kernels in bi-color varieties. Pollen from white corn will not affect yellow or bi-color varieties.

Sweet Corn Varieties

Sugar-enhanced (se) Varieties

Yellow	Maturity
Legend	Early
Sweet Riser	Early
HMX 5346e	for trial
Amaize	2nd Early
Incredible	Main
Kandy Korn	Main
Tuxedo	Main
Sugar Ace	Main
Bi-color	
Seneca Arrowhead	Early
Trinity	Early
Crystal Bell	
Sweet Chorus	Early
Temptation	Early
Sweet Symphony	2nd Early
Double Choice	Midseason
Jackpot	Main
Sunset	for trial
Lancelot	Main
Delectable	Main
Precious Gem	Main
Wizard	Main
Serendipity	Main-for trial
White	
Sweet Ice	Early
Seneca Sensation	2nd Early
Alpine	Main
Silver King	Main

Supersweet (sh2) Varieties

Yellow	Maturity
Attribute (Bt corn)	for trial
Bandit	for trial
Fortune	for trial
Challenger	2nd Early
Saturn	2nd Early
Endeavor	2nd Early
Bunker Hill	Main
Flagship II	Main
Morning Star	Main
Zenith	Main
Bi-Color	
Candy Corner	2nd Early
Everprime	2nd Early
Festival	2nd Early
Seneca Appaloosa	for trial
Fresh Start	for trial
Bi-Color (Cont.)	
Candy Store	Main
Crisp 'n' Sweet 710A	Main
Phenomenal	Main
Quest	for Iowa
Autumn Star	for Iowa
White	**Maturity**
Ice Queen	Early
SummerSweet 781 Ultra	Main
Vail	Main
Silver Xtra Sweet	Main
Even Sweeter	Main

Standard (su) Varieties

Yellow	Maturity
Seneca Horizon	Early
Rival (processing)	
White	
Silver Queen	Main-Late

SPACING AND SEEDING

Rows 30 to 40 in. apart. Plant early varieties 8 to 10 in. apart in the row, late varieties 9 to 12 in. apart in the row. Seed 10 to 15 lb. per acre.

FERTILIZING

Lime: To maintain a soil pH of 6.0 to 6.5.

Preplant: N, 60 lb. per acre; P_2O_5, 0 to 100 lb. per acre; K_2O, 0 to 150 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. For early season varieties, apply a starter fertilizer at planting. Do not exceed 80 to 100 lb. of N + K_2O per acre in the fertilizer band (2 inches to the side of the row and 2 inches below the seed). A good starter fertilizer would be 200 lb. per acre of 6-24-24 or 10 gal. of 10-34-0 or similar analysis. On sandy soils, broadcast 30 lb. or band 15 lb. sulfur per acre.

Sidedress N: For loam or finer textured soils, apply 30 to 40 lb. N per acre when plants are 4 to 5 inches tall but before they are 10 inches in height. If the soil organic matter content exceeds 3% and/or sweet corn follows a legume, this sidedressed N application could be skipped provided excessive rainfall has not occurred. For irrigated sandy loam soils along river areas, the N preplant application should be replaced with two sidedressings of approximately 40 lb. N per acre each: one when 4 to 5 inches tall (4 to 5th leaf) and the other at 10 inches in height (10 to 12 leaf).

DISEASES CONTROLLED	TREATMENT	COMMENTS
Seed rot and damping off	Captan 50W at 1 tsp. per lb. of seed.	Most seed companies deliver pretreated seed.
Rust	Plant rust-resistant hybrids.	Comet, Jubilee, Incredible, Sweetie 82, and many others. Note however, that a new strain of common rust has been reported that is able to overcome the resistance of many hybrids.
	Tilt/Propimax at 4 fl. oz. per acre.	Begin applications when rust pustules first appear. Repeat at 7-14 day intervals. Do not apply more than 16 fl. oz. per acre per season. 14 day PHI.
	Bravo 500 at 11/8 to 2 3/4 pt. per acre. Bravo Ultrex, Equus DF at 0.7 to 1.8 lb. per acre. Bravo Weather Stik, Equus 720, Agronil 720 at 0.75 to 2 pt. per acre or Echo at labeled rates. Do not apply to sweet corn to be processed.	Begin applications when conditions favor disease development. Repeat at 4-7 day intervals, beginning before tassel emergence and ear formation. Do not feed treated forage to livestock. 14 day PHI.
	OR	
	Quadris Flowable at 6.2 to 9.2 fl. oz. per acre.	Do not apply more than 2 sequential applications of Quadris before alternating to a fungicide with a different mode of action. 4 hour REI. 7 day PHI.
	OR	
	Dithane, Manzate, Penncozeb, or Maneb or Manex at labeled rates.	See comments for Bravo. 7 day PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Smut	Use tolerant hybrids such as Apache, Bellringer, Commanche, Comet, Gold Cup, and Merit.	
Stewart's Wilt	Plant wilt-resistant hybrids.	Apache, Comet, Comanche, Gold Cup, Incredible, Sweet Sue, Seneca Sentry, Miracle, How Sweet It Is.
	Use an insecticide to control flea beetles.	Especially on more susceptible hybrids following a mild winter.
"Helminthosporium" leaf blights, and anthracnose	Plant resistant varieties. Follow a 2-3 year plan.	
	Tilt/Propimax at 2 to 4 fl. oz. per acre. OR	Begin applications when disease first appears. Repeat at 7-14 day intervals. Do not exceed 16 fl. oz. per acre per season. Also controls grey leaf spot and eyespot. 14 day PHI.
	Helminthosporium blights only: Bravo 500 at 11/8 to 2 3/4 pt. per acre. Bravo Ultrex, Equus DF at 0.7 to 1.8 lb. per acre. Bravo Weather Stik, Equus 720 Agronil 270 at 0.75 to 2 pt. per acre or Echo at labeled rates. Do not apply to sweet corn to be processed. OR	Begin applying fungicides at the first sign of disease. Apply at 4-7 day intervals, or as needed to maintain control. Do not feed treated forage to livestock. 14 day PHI.
	Dithane, Manzate, Penncozeb, or Manex II at 1.5 lb. per acre for dry (WP, DF, or DG) formulations or 2.4 pt. per acre for flowable (F) formulations. OR	Begin applications at the first sign of disease. Apply at 4-7 day intervals, or as needed. Do not feed treated forage to livestock. 7 day PHI.
	Quadris Flowable at 9.2 to 15.4 fl. oz. per acre. Not labeled for anthracnose.	Do not apply more than 2 sequential applications of Quadris before alternating to a fungicide with a different mode of action. 4 hour REI. 7 day PHI.
Virus diseases: Maize dwarf mosaic, chlorotic dwarf, and wheat streak mosaic	Plant resistant or tolerant varieties.	Bi-Guard, HMX8396, HMX9352S, Silverett, Sundance, WH3443.
	Control Johnsongrass and volunteer wheat.	

HERBICIDES*	TREATMENT**	COMMENTS
PREEMERGENCE		
Aatrex or others 4L, 80W, Nine-0	1 to 2 qt. per acre on of 4L, 1.25 to 1.5 lb. per acre of 80W, or 1.1 to 2.2 lb. per acre of Nine-0.	Apply at planting time or before corn emerges. **Caution:** Atrazine remains in the soil and may carryover and injure susceptible crops sown in the fall or following spring (tomatoes, cucumbers, melons, etc.). Consult label for suggested rotational crops. Not effective on muck soils. RUP.
Bladex 4L or 90DF	1 qt. per acre of 4L, or 1.1 lb. per acre of 90DF.	Apply immediately after planting. Supersweet (sh_2) corn may be injured by Bladex. RUP. Enclosed cab required.
Dual Magnum, Dual II Magnum	1 pt. per acre on coarse soils, or 2 pt. per acre on fine soils.	Apply at planting time or before corn emerges or as a diluted spray after emergence. May be mixed with atrazine or Bladex. Use low rates of each herbicide in combinations.
Lasso 4E	2 qt. per acre on light-colored soils, 3.25 qt. per acre on dark colored soils.	Apply at planting time or before corn emerges. May be mixed with atrazine or Bladex. Use low rates of each herbicide in combinations. RUP.
Eradicane 6.7E	4.75 to 5.3 pt. per acre.	Will suppress wild proso millet. Must be incorporated. Contains an extender that may lengthen the period of control.
Prowl 3.3E	1.8 to 4.8 pt. per acre.	Apply after planting but before corn emergence, or postemergence until corn is 20-24 in. tall or shows 8 leaf collars. Plant corn at least 1.5 in. deep and make sure seed is well-covered. Use drop nozzles and directed spray for post applications if necessary to get spray to soil. Will not control emerged weeds.
Frontier 6E, Outlook 6.0	1 to 2 pt. Frontier or 10 to 21 fl. oz. Outlook per acre. Use lower rate on coarse soils low in organic matter.	Apply preemergence for best activity. 50 day PHI.
Sutan+6.7E	4.75 to 7.33 pt. per acre.	Must be incorporated.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
POSTEMERGENCE		
Aatrex or other Atrazine products	1 to 1.5 pt. 4L per acre or 0.6 to 0.9 lb. of 80W, or 0.55 to 0.83 lb. of Nine-0 plus 1 qt. COC per acre.	Apply before weeds are 1.5 in. tall. Check all label precautions and replant restrictions. Total Atrazine used per year must not exceed 2.5 lb. a.i. per acre. RUP.
2, 4-D (4 lb./gal.)	0.5 to 0.75 pt. amine per acre.	Apply after weeds are up but are still small. Apply with straight boom sprayer if corn is small; do not apply when corn is 12 in. or taller. Avoid drift onto other vegetable crops.
Basagran 4L	0.75 to 1 qt. per acre on small emerged weeds. Repeat application at 7-10 days for yellow nutsedge if necessary.	Do not apply to corn that has been subjected to stress because injury may result.
Gramoxone Extra 2.5E	0.8 pt. per acre plus 1 qt. nonionic surfactant per 100 gallons.	Specialized equipment for directed spray required. Corn must be 10 inches tall from ground to top of whorl. Spray must reach no higher on corn than 3 in. above soil. Improper application can severely injure corn. RUP.
Accent	0.66 oz. 75DF per acre. Always add COC at 1% or non-ionic surfactant at 0.25%.	**Minnesota, Iowa, Illinois, and Wisconsin only.** Use only on labeled varieties. **Processing sweet corn only.** Do not apply any organophosphate insecticide or other herbicide within 7 days before or 3 days after Accent application. Label restrictions apply.
Permit 75DF	0.66 oz. per acre.	Apply from spike to layby. **Processing sweet corn only.** Certain varieties may be severely injured. The manufacturer does not list tolerant varieties and recommends checking with processors for hybrid safety data. **Do not use on Jubilee.**
Aim	0.33 oz. per acre. Always add 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to weeds up to 4 in. tall and up to the 8 leaf collar stage of sweet corn. **Recommended for processing sweet corn only.** Do not exceed 1.24 fl. oz. per acre per season.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

HERBICIDE*	TREATMENT**	COMMENTS
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. per acre plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	Apply to emerged weeds before or after seeding, but before crop emerges. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before the crop emerges. These rates are for annual weeds at application volumes of 10 to 40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.
** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Seed corn maggot, seed corn beetle, wireworms	Plant seed that has been treated with an insecticide prior to planting. Use either diazinon or a combination of diazinon and lindane. Follow label directions.	Although most sweet corn seed has been treated with a fungicide, it is seldom treated with an insecticide to prevent seed and seedling damage.
Corn rootworms	Aztec 2.1G at 6.7 oz. per 1000 linear ft. of row. OR	Apply any of these in a 7 in. band over the row and behind the planter shoe in front of the press wheel.
	Counter 15G, or Lorsban 15G at 8 oz. per 1000 linear feet of row. OR Counter 20CR or Thimet 20G at 6 oz. per 1000 linear feet of row. OR Mocap 10G at 10.5 oz. per 1000 linear feet of row. OR Fortress 2.5G at 6 oz. or 5.0G at 3 oz. per 1000 linear feet of row. OR	If few or no rootworm beetles were present in the field the previous year, then there is little chance of a damaging infestation. If sweet corn was grown in the field the previous year and a regular spray schedule was followed during silking, then there is little chance of a damaging infestation.
	Force 3G at 4 to 5 oz. per 1000 linear feet of row. OR	DO NOT place Lorsban, Mocap, or Thimet in the furrow or in direct contact with the seed.
	Capture 2EC at 0.3 fl. oz. per 1000 linear feet of row.	May also provide control of cutworms, and other soil pests. 30 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea beetle	Resistant varieties.	Use varieties that are resistant to Stewart's wilt, which is vectored by the beetles. See page 141.
	Sevin XLR at 2 qt. per acre. OR Lorsban 4E at 2 to 3 pt. per acre.	2 day PHI. 35 day PHI.
	OR Asana XL at 5.8 to 9.6 fl. oz. per acre.	1 day PHI.
	OR Warrior 1EC at 2.6 to 3.8 fl. oz. per acre. OR	Do not exceed 3.84 pt. per acre per season. 1 day PHI.
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre. OR	Do not exceed 12.8 fl. oz. per acre per season. 1 day PHI.
	Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre. OR Pounce 3.2EC at 4 to 8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre.	1 day PHI. 1 day PHI.
Cutworms	Lorsban 4E at 2 to 4 pt. per acre. OR	Most effective when soil is moist. If ground is dry, cloddy, or crusty, shallow incorporation before or soon after treatment may improve control. 35 day PHI.
	Asana XL at 5.8 to 9.6 fl. oz. per acre. OR Warrior 1EC at 2.6 to 3.8 fl. oz. per acre. OR	1 day PHI. Do not exceed 3.84 pts. per acre per season. 1 day PHI.
	Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre. OR Pounce 3.2EC at 4 to 8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre. OR Capture 2EC at 2.1 to 6.4 fl. oz. per acre. OR Baythroid 2E at 0.8 to 1.6 fl. oz. per acre.	1 day PHI. 1 day PHI. 1 day PHI. 0 day PHI.
Corn leaf aphid	Malathion 5EC or 57EC at 1.5 pt. per acre.	Apply when less than 50% of the field is pollinated and more than 50% of the plants are infested with at least 50 aphids. 5 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
European corn borer	*Monitor with pheromone or blacklight traps.*	The most important spray for corn borer control is when green tassels have just begun to shoot.
Threshold More than 5 moths per night in pheromone traps and green silks are present	Warrior 1EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 3.84 pts. per acre per season. 1 day PHI.
	OR	
	Capture 2 EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 1 day PHI.
	OR	
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 10 applications per season. 0 day PHI.
	OR	
	Penncap-M at 2 to 4 pt. per acre.	**Not for corn earworms.** 3 day PHI.
	OR	
	Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre.	Do not apply more than 1.2 lb. a.i. of Ambush and/or Pounce per acre per season. 1 day PHI.
	OR	
	Pounce 3.2EC at 4 to 8 oz. or 25WP at 6.4 to 12.8 oz. per acre.	
	OR	
	Lannate 90SP at 0.3 to 0.5 lb. or LV at 1 to 1.5 pt. per acre.	**Not for corn earworms.** 0 day PHI for ears, 3 days for forage.
	OR	
	Sevin XLR Plus at 2 qt. per acre.	2 day PHI.
	OR	
	SpinTor 2SC at 3 to 6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. 1 day PHI.
	OR	
	Larvin 3.2 at 2 to 30 fl. oz. per acre.	Do not exceed 300 fl. oz. per acre per season. 0 day PHI.
Corn earworm	*Monitor with pheromone traps.*	Begin sprays when ears begin to silk and when pheromone traps show need. Stop sprays when more than 90% of silks are brown.
	Warrior 1 EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 3.84 pts. per acre per season. 1 day PHI.
	OR	
	Capture at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl . oz. per acre per season. 1 day PHI.
	OR	
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 10 applications per season. 0 day PHI.
	OR	
	Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre.	Do not apply more than 1.2 lb. a.i. of Ambush and/or Pounce per acre per season. 1 day PHI.
	OR	

INSECTS CONTROLLED	TREATMENT	COMMENTS
Corn earworm (cont.)	Pounce 3.2EC at 4 to 8 oz. or 25WP at 6.4 to 12.8 oz. per acre.	
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	**Not for European corn borer.** Do not exceed 0.5 lb. a.i. per acre per season. 1 day PHI.
	OR	
	Sevin XLR Plus at 2 qt. per acre.	2 day PHI.
	OR	
	SpinTor 2SC at 3 to 6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. 1 day PHI.
	OR	
	Larvin 3.2 at 20 to 30 fl. oz. per acre.	Do not exceed 300 fl. oz. per acre per season. 0 day PHI.
Fall armyworm	*Monitoring.*	Fall armyworms can be monitored with pheromone traps or by looking for damage to whorl-stage corn. Best time to treat is when tassels are just beginning to emerge. Don't wait until silks appear to control fall armyworm.
	Warrior 1 EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 3.84 pts. per acre per season. 1 day PHI.
	OR	
	Baythroid 2E at 2.8 fl. oz. per acre.	Do not exceed 10 applications per season. 0 day PHI.
	OR	
	Capture 2EC at 2.1 to 6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 1 day PHI.
	OR	
	Ambush 2EC at 6.4 to 12.8 fl. oz. or 25WP at 6.4 to 12.8 oz. per acre.	Do not exceed 1.2 lb. a.i. of Ambush and/or Pounce per acre per season. 1 day PHI.
	OR	
	Pounce 3.2EC at 4 to 8 oz. or 25WP at 6.4 to 12.8 oz. per acre.	
	OR	
	Lannate 90SP at 0.5 lb. or LV at 1.5 pt. per acre.	0 day PHI for ears, 3 days for forage.
	OR	
	Asana XL at 9.6 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. per acre per season. 1 day PHI.
	OR	
	Spin Tor at 3 to 6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. 1 day PHI.
	OR	
	Larvin 3.2 at 20 to 30 fl. oz. per acre.	Do not exceed 300 fl. oz. per acre per season. 0 day PHI.

MONITORING EUROPEAN CORN BORER AND CORN EARWORM

One of the keys to successfully managing corn borers and corn earworms on sweet corn is to be able to determine when the insects are active. European corn borers can be monitored effectively with blacklight traps and field observations, and corn earworms can be monitored with pheromone traps. When moths are being caught in the traps, it means that egg laying is taking place. Corn borer eggs are laid on the leaves, usually on the underside, in the region of the ear. The larvae will feed on the leaves and later may migrate to the ear, if one is present. Corn earworm moths lay their eggs directly on green silks. The young larvae that hatch out of those eggs will follow the silks down into the tip of the ear. Because the egg laying behavior of the two insects differs, the strategies for their control also differ. Corn borers can be controlled by spraying during the late whorl and tasselling stages as well as during the silking stage. The migrating larvae should contact a lethal dose of insecticide while moving to the ear zone. Corn earworms must be controlled by directing the sprays at the silks so that when the eggs hatch the young larvae will immediately contact the insecticide.

For corn borers, treat during the late whorl stage if 20% or more of the plants show larval feeding. The presence of large numbers of moths in the light trap is also justification for insecticidal treatment. One application during the late whorl stage followed by additional treatments every 5 days until just prior to harvest will usually provide adequate control. For corn earworms, treatment is justified if fresh green silks are present *and* moths are being caught in pheromone traps. In general, the higher the moths catches, the shorter the interval between sprays. If fewer than about 5 moths are being caught per night, a spray interval of 5 days should be adequate. As moth catches approach the level of 50-100 per night, a spray interval of 2-3 days would be more appropriate. The exact determination of the spray interval depends on many factors, including how much damage you can tolerate, the value of the crop, and the cost and effectiveness of the insecticide. Stop treating for corn earworms when 90% of the silks are brown.

Obviously, growers should not treat separately for these two pests. Some of the insecticides we recommend are effective against both species. Choose the insecticides that are more effective against the particular pest that is more prevalent at the time. If both pests are present, choose an insecticide that will adequately control both of them.

SOURCES OF TRAPS

Corn earworm and European corn borer traps

Bob Poppe's Service
R.R. #1, Box 33
Lexington, IL 61753
PH: 309-723-3201

Pheromones/Traps

Suterra
213 S.W. Columbia
Bend, OR 97702-1013
PH: 866-326-6737
www.suterra.com

Gempler's
P.O. Box 270
100 Countryside Dr.
Belleville, WI 53508
PH: 800-382-8473
www.gemplers.com

Pheromones/Traps (cont.)

Great Lakes IPM
10220 Church Rd
Vestaburg, MI 48891-9746
PH: 517-268-5693
www.greatlakesipm.com

Insects Limited Inc.
16950 Westfield Park Rd.
Westfield, IN 46074-9374
PH: 317-896-9300
www.insectslimited.com

Pacific Biocontrol Limited
620 E. Bird Lane
Litchfield Park, AZ 85340
PH: 623-935-0512 or 800-999-8805
www.pacificbiocontrol.com

Pheromones/Traps (cont.)

Scentry Biologicals, Inc.
610 Central Ave.
Billings, MT 59102
PH: 800-735-5323
www.scentry.com

Trece Incorporated
P.O. Box 6278
1031C Industrial St.
Salinas, CA 93901
PH: 831-758-0204
www.trece.com

Sweet Potato

Varieties

Beauregard:	Early, light red skin, orange flesh, increasingly popular.
Centennial:	Soft-fleshed type, orange skin.
Hernandez:	Copper skin, deep orange flesh.
Julian:	Deep orange, good quality (same as Centennial).
Nugget:	Firm-fleshed type, orange skin, orange flesh, good quality, excellent keeper.

Plant Production

Select seed stock from high-yielding hills that are smooth, well-shaped, and free from diseases (scurf, internal cork, wilt, black rot) and insect injury. Where internal cork is present, obtain seed stock from suppliers who have cork-free stock. Store the seed stock in new crates to avoid disease contamination. Seed potatoes should be at least 1.5 in. in diameter. One bushel of small- to medium-sized roots should produce 2,000 to 2,500 plants (slips) from three pullings.

Treating seed before planting with Mertect 340-F will protect roots from infection by certain disease-causing organisms. Bed the seed stock in new, clean sand taken from upland banks or pits. Allow 10 to 12 sq. ft. of bed area per bushel of seed. Maintain plant bed temperature at 75 to 85°F.

Transplanting and Spacing

Transplanting machines are available for mechanically planting sweet potato slips. Common spacing is 1 ft. apart in the row, with rows 3 to 4 ft. apart, depending upon the cultivating and harvesting equipment used. 14,520 slips per acre are required at the 1 ft. by 3 ft. spacing, while 10,890 are needed at the 1 ft. by 4 ft. spacing. Transplant only strong, stocky slips. Yields can be increased up to 100 bu. per acre by using strong transplants.

Fertilizing

Lime: None usually necessary. Soil pH of 5.0 to 6.0 is satisfactory.

Preplant: N, 30 lb. per acre; P_2O_5, 0 to 75 lb. per acre; K_2O, 0 to 250 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. Set the slips with a starter solution at the rate of 1 cup (8 oz.) per plant.

Sidedress N: None usually necessary on finer textured soils. On the irrigated sands, sidedress with 30 to 50 lb. N per acre approximately 3 to 4 weeks after transplanting.

Harvesting

Remove vines by cutting with a rotary mower. Dig only those potatoes that can be picked up immediately and not left out overnight. Temperatures below 50°F can chill potatoes and cause internal breakdown in storage. Potatoes will sunburn if left in direct sunlight over 1 hour. Field grading is important.

Prevent skinning and breaking. Use cotton gloves when placing potatoes in crates. Place well shaped No. 1's with No. 2's, and cuts with culls.

Storing

When the storage house is filled, raise the temperature to 85°F. Keep it at this temperature 6-8 days, with 85 to 90% humidity for proper curing. After curing, the temperature may be dropped gradually to 55°F. Hold this temperature until potatoes are marketed or used for producing slips.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Black rot, foot rot, Fusarium wilt, and scurf	Plant disease-free seed and/or resistant varieties.	
	Follow 3-4 year crop rotations.	
	Dip roots or sprouts in Mertect 340F (8 fl. oz. per 7.5 gal. water) or Thiram 75W (1 lb. per 7.5 gal. water).	Dip roots and sprouts in solution for 2 minutes, and plant immediately.
Storage rots	Fumigate storage boxes.	Cure and store only healthy, blemish-free tubers.
	Use Botran as a post-harvest dip.	

HERBICIDE*	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on dark-colored soils in at least 50 gal. water per acre.	Apply up to 6 weeks after transplanting, using 50-mesh or larger screens. This material gives best results on light, sandy soils.
Command 3ME	1.3 pt. to 4 pt.	Apply prior to planting, or apply a maximum of 1.5 pt. after transplanting and before weeds emerge. 95 day PHI.
POSTEMERGENCE Fusilade DX 2E	10 to 12 fl. oz. per acre plus 1 pt. nonionic surfactant per acre.	Apply to actively growing grass. 55 day PHI.
Select 2EC	6 to 16 fl. oz. for annual grasses; 8 to 16 fl. oz. for perennial grasses; plus 1 qt. COC per 25 gal. spray solution (1% v/v).	Apply to actively growing grasses. Wait at least 14 days between applications. Maximum 32 fl. oz. per season. 30 day PHI.
NON-SELECTIVE HERBICIDES		
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before planting in spring or after harvest in fall. These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Wireworms, flea beetle larvae	Lorsban 15G at 13.5 lb. per acre.	Evenly distribute granules over treated area, and after application incorporate to depth of 4 to 6 in. by rotary hoe or disc cultivator. 125 day PHI.

Tomato

Fresh Market Varieties

Variety	Season	Crack Resistance	Firmness	Vine Type[1]
Sunshine	First Early	Good	Firm	D
Florasette	Early	Good		D
Jet Star	Early	Good	Fair	I
Celebrity	Mid-Early	Fair	Fair	D
Mountain Delight	Mid	Good	V. Firm	D
Sun Gem	Mid	Good	Firm	D
Floralina	Main	Good	Firm	D
Florida 47	Main	Good	Firm	D
Florida 91	Main	Exc.	Firm	D
Mountain Fresh	Main	Good	Firm	D
Mountain Spring	Main	Exc.	V. Firm	D
Primetime	Main	Good	Firm	D
Sun Brite	Main	Good		D
Sunpride	Main	Good		D
Ultrasweet	Main	Exc.	Fair	I

[1] Vine Type: I = Indeterminate (long vine); D = Determinate (short vine).

Transplants

Both fresh market and processing tomatoes are usually started as transplants, although processing tomatoes may also be direct-seeded. 4- to 8-week old transplants, greenhouse grown in multi-cell trays or dug from disease-free fields and rushed to growers for immediate field planting, give maximum assurance of good stands and high yields. Bad weather, however, may seriously delay transplanting, damage stands, and lower yields. In an emergency, plants may be kept in reasonably good condition stored at 50 to 55°F, provided the combined handling, transit, and storage time does not exceed 10 days.

Ethephon Application (for processing only)

Applications of ethephon results in acceleration and concentration of fruit ripening, thus facilitating once-over machine harvesting and the opportunity to schedule multiple hand harvests.

For Machine Harvest: 3.25 pt. Ethrel or Cepha in 5 to 70 gal. of water per acre applied as spray over entire plant when 10 to 30 percent of fruits are ripe. Harvest 15 to 21 days after treatment for optimum ripe fruit accumulation.

For Hand Harvest: 3.25 pt. Ethrel or Cepha in 5 to 70 gal. of water per acre applied at mature green fruit stage increases first harvest yields. Application after the first or second harvests will increase ripe fruit yields in subsequent harvest and allow earlier and more complete harvest of fruit load.

Spacing and Cultural Practices

Fresh market: Space rows 5 to 6 ft. apart and plants 1.5 to 2.5 ft. apart in the row. Tomatoes are often grown on beds covered with black plastic mulch to promote earliness. They may be left to grow over the ground or may be supported by cages, stakes, or a trellis-weave system. Tomatoes supported by stakes or trellis are often pruned: several or all of the branches up to the branch just below the first flower cluster are removed when the branches are a few inches long. Supported tomatoes produce higher quality fruit than unsupported plants. Pruned plants produce larger fruit than unpruned plants, but the total number of fruit is reduced.

Processing: Row spacing and bed formation should be determined by harvesting equipment. Double rows 16 to 20 in. apart on 5 to 6 ft. centers are common, with plants 1 to 2 ft. apart in the row.

FERTILIZING

Lime: To maintain a soil pH of 6.0 to 6.8.

Preplant: N, for soils with more than 3% organic matter and following soybeans, alfalfa, or a grass-legume hay crop, no N is needed. For soils with less than 3% organic matter and the above rotation, apply 30 lb. N per acre. For fresh market tomatoes following corn, rye, oats, wheat, or a vegetable crop, apply 60 lb. N per acre; P_2O_5, 0 to 250 lb. per acre; K_2O, 50 to 300 lb. per acre. Adjust according to soil type, previous management, and soil test results for your state. Set the transplants with a starter solution at the rate of 1 cup (8 oz.) per plant. See p. 3 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.

Sidedress N: Apply from 0 to 50 lb. of N per acre at the time of fruit set or when fruit first appear. The N source should be urea or calcium nitrate. If the rotation includes soybeans, alfalfa or another legume crop, the sidedress N should not be necessary. Also, if the plastic mulch culture system is used a sidedressed N application should not be needed, unless extensive rainfall occurs. Tomatoes are susceptible to calcium deficiency even when adequate levels of calcium are present in the soil. This disorder is called "blossom end rot." It often occurs under conditions of inadequate or excessive watering and/or excessive N fertilization with an ammonium source. Where the soil pH has been adjusted to 6.0 or above, additional soil-applied calcium does not correct the disorder. Addition of a foliar spray directly to the developing fruit may reduce the incidence of blossom end rot. Use calcium nitrate at the rate of 10 to 15 lb. per 100 gallons of water per acre.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Anthracnose	3-4 year crop rotation.	Rotate out of fields with a history of anthracnose.
	Several chlorothalonil formulations are labeled for use including those under the brand names Agronil, Bravo, Echo, Equus, and Terranil. Rates vary per formulation.	Fungicides and application schedules that are effective against early blight and Septoria leaf spot will protect against anthracnose infection. Note that higher rates may be required for anthracnose protection. 0 day PHI. 48 hour REI.
	OR	
	Dithane DF at 1.5 to 3 lb. per acre, Dithane F-45 at 1.2 to 2.4 qt. per acre, Dithane M-45 at 1.5 to 3 lb. per acre, or Mankocide at 2.5 to 5 lb. per acre.	5 day PHI. 24 hour REI.
	OR	
	Quadris 2.08EC at 5.0 to 6.2 fl. oz. per acre. Apply at 7-14 day intervals.	Do not apply Quadris more than 3 times before alternating with a fungicide with a different mode of action. 0 day PHI.
	OR	
	Apply Flint at 3 to 4 oz. per acre.	3 day PHI. Do not exceed 16 oz. and 4 applications per season. No more than 3 sequential applications of Flint or other strobulurin fungicide before alternating to fungicide with a different mode of action.
	OR	
	Ziram 76DF at labelled rates.	Use an effective spreader sticker. Early season use only. **Not for cherry tomatoes.**

DISEASES CONTROLLED	TREATMENT	COMMENTS
Bacterial canker	Obtain disease-free seed and/or transplants from a reliable source. Copper sprays are generally ineffective in controlling canker.	Fields with a history of canker should be planted to crops other than tomatoes, potatoes, peppers, and eggplant for at least 3 years. Sanitize machinery, seedlings, and plant production materials (wooden flats, plastic trays, greenhouse benches, and wooden stakes) with a disinfectant solution such as 10% chlorine bleach solution or other appropriate solutions. Avoid working in wet canker fields.
Bacterial spot, bacterial speck	**For transplant facility treatment:**	
	Use seed that has been tested for bacterial spot contamination. Inspect transplants daily for disease outbreaks.	
	Agri-mycin 17 at 200 ppm.	Begin applications at the 2 leaf stage on a 4-5 day schedule until transplanted in the field. 12 hour REI.
	OR	
	Kocide DF at 2 to 3 TBSP per 1000 square ft., Kocide 2000 at 1.5 to 2.5 TBSP per 1000 square ft., or Kocide 101 at 4 to 6 TBSP per 1000 square ft.	Repeat at 7-10 day intervals.
	OR	
	Cuprofix Disperse at 2.5 to 6 level teaspoons/100 sq. ft.	
	For field treatment:	
	Apply 2-4 copper sprays before disease appears around the time of first bloom. Use a 7-10 day spray interval.	Bacterial spot represents the greater threat to Midwestern tomato production. Bacterial speck is more likely to spread in cool wet weather; bacterial spot is favored by warm wet weather. 0 day PHI.
	Copper bacteriacides that may be effective in reducing the rate of spread of bacterial spot and speck include copper hydroxide, copper sulfate, and copper resinate. Apply at label rates.	
	OR	
	Actigard at 1/3 to 3/4 oz. per acre. Use low rate early in season and increase with time. See label.	Use up to 6 weekly applications. 14 day PHI. Maybe effective when used with other labeled pesticides.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Blossom end rot	Choose a tomato cultivar that is less prone to blossom end rot.	A physiological disorder related to calcium deficiency. Rot is promoted by variances in available water and excessive vine growth rates. Reduce incidence by maintaining an even irrigation schedule.
Buckeye rot	Ridomil Gold EC at 1 pt. per acre. OR	Apply 4-6 weeks after planting. 28 day PHI.
	Quadris 2.08EC at 5.0 to 6.2 fl. oz. per acre. Apply at 7 to 14 day intervals.	Do not apply Quadris more than 3 times before alternating with a fungicide with a different mode of action. 4 hour REI. 0 day PHI.
Early blight, Septoria leaf blight	Resistant varieties.	Use wilt resistant "VF" cultivars, and avoid fields with a wilt history. Tomatoes weakened by wilt disease may be more prone to leaf blights.
	3-4 year rotation with unrelated crops.	Rotate out of fields with a history of early blight or Septoria leaf spot.
	Flint at 2 to 3 oz. per acre for early blight and 3 to 4 oz. per acre for Septoria. OR	Up to 4 applications per year (16 oz.). Do not apply more than 3 sequential applications of Flint before alternating with a pesticide with a different mode of action. 3 day PHI.
	Quadris 2.08EC at 5.0 to 6.2 fl. oz. per acre. Apply at 7 to 14 day intervals. OR	Quadris provides best control of foliar disease when applied between initial flower formation and color break of fruit. Do not apply more than 3 sequential applications of Quadris before alternating with a fungicide with a different mode of action. 0 day PHI.
	Bravo 500 at 2 to 3 pt. per acre, Bravo Ultrex at 1.3 to 1.8 lb. per acre, Bravo WS at 1.37 to 2 pt. per acre, or Agronil, Echo, Equus or Terranil Cu according to label directions. OR	0 day PHI.
	Dithane DF at 1.5 to 3 lb. per acre, Dithane F-45 at 1.2 to 2.4 qt. per acre, Dithane M-45 at 1.5 to 3 lb. per acre, or Mankocide at 2.5 to 5.0 lb. per acre. OR	5 day PHI.
	Ziram 76DF at 4.0 lb. per acre.	**Not for cherry tomatoes.** Use with effective spreader sticker. 7 day PHI.

DISEASES CONTROLLED	TREATMENT	COMMENTS
Late blight	Ridomil MZ at 1.5 to 2 lb. per acre.	14 day spray interval. 5 day PHI.
	OR	
	Ridomil Gold Bravo at 2 lb. per acre.	14 day spray interval. 0 day PHI.
	OR	
	Flint at 4 oz. per acre. Must be tank mixed and alternated with other labeled fungicides. See label.	3 day PHI. Maximum 16 oz. and 4 applications per season. no more than 3 sequential applications of Flint or other strobulurin fungicide before alternating to fungicide with a different mode of action.
	Quadris 2.08EC at 5.0 to 6.2 fl. oz. per acre.	Do not apply Quadris more than once before alternating with a fungicide with a different mode of action. Do not exceed 6 applications per year.
	OR	
	Chlorothalonil and Mancozeb products may be used according to the rates and schedules used under early blight, Septoria.	0 day PHI. .
Powdery mildew	Quadris 2.08EC at 5.0 to 6.2 fl. oz. per acre. Apply at 7 to 14 day intervals	Do not apply Quadris more than once before alternating with a fungicide with a different mode of action.
	OR	
	Nova 40W at 2.5 to 4.0 oz.	Do not exceed 21 days between applications. 0 day PHI.
Sclerotinia stem rot	Use disease-free transplants.	Avoid fields with a history of stem blight.
Phytophthora blight	Avoid fields with a history of the disease and poorly drained fields in close proximity to pepper or cucurbit fields that sustained Phytophthora blight in the past. Soil applications of Ridomil Gold EC (4 pt./A) may be effective if disease-prone fields cannot be avoided. Foliar sprays of Ridomil Bravo Gold during wet summer weather also may help control the disease. Protectant fungicides such as chlorothalonil and mancozeb will offer some degree of control.	The pathogen overwinters as thick-walled spores in the soil. Spores may survive indefinitely. There are no resistant varieties. Water management is very important in avoiding serious losses.

DISEASE CONTROLLED	TREATMENT**	COMMENTS
Root-knot nematode	Use root-knot resistant tomato varieties where available.	Sample fields during growing season for plant parasitic nematodes before planting. Avoid fields with high numbers of root-knot nematodes.
	Methyl bromide or Sodium methyl dithiocarbamate or Vydate L.	Methyl bromide and sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate gives adequate control when nematode populations are low to moderate.

HERBICIDE	TREATMENT**	COMMENTS
PREEMERGENCE		
Dacthal 75WP	8 lb. on light-colored soils (less than 2% organic matter), 14 lb. on darker colored soils in at least 50 gal. water per acre.	Apply 4-6 weeks after transplanting or on direct seeded plants at 4-6 inches in height. Use 50-mesh or larger screens. Not effective on muck or other high organic soils.
Devrinol 50DF	2 lb. per acre on light-colored soils (less than 2% organic matter), 4 lb. on other soils.	Incorporate 1-2 in. deep before seeding or transplanting. After harvest or prior to planting succeeding crops, a deep moldboard or disc plowing operation must be carried out. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months after using Devrinol.
Sencor 4F or 75 DF	0.5 to 1 pt. of 4F or 0.33 to 0.66 lb. of 75DF per acre. TRANSPLANTS ONLY.	Apply as a broadcast spray immediately before transplanting and incorporate to a depth of 3-4 in. This application may be made alone or in a tank-mix combination with trifluralin adjusted for soil type.
Tillam 6EC	2.7 qt. per acre on light-colored soils, 4 qt. per acre on darker soils.	**Transplants:** Apply and incorporate 2-3 in. into soil before transplanting. **Seeded:** Apply as a directed spray to clean cultivated soil, and incorporate or irrigate in after tomatoes are well-established. 8 day PHI.
Trifluralin (4 lb. /gal.)	0.6 pt. on light-colored soils (less than 2% organic matter), 1.5 pt. on darker colored soils in 25 gal. or more water per acre. TRANSPLANTS ONLY.	Apply before planting and incorporate immediately to about 4 in. deep. May cause early stunting unless transplant roots are dipped in carbon slurry (2 lb. per gal.) before planting or 2 oz. carbon per gal. is put in transplant water.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

WEEDS CONTROLLED	TREATMENT*	COMMENTS
POSTEMERGENCE		
Poast 1.5E	1.0 to 1.5 pt. per acre plus 1 pt. nonionic surfactant per acre. Transplants or seeded.	Apply to actively growing grass. Maximum of 4.5 pt. per acre per season. 20 day PHI.
Sencor 4F or 75DF	0.5 to 0.75 pt. of 4F or 0.33 to 0.5 lb. of 75DF per acre. Rate may be doubled if directed spray is used and spray does not contact tomato foliage.	Broadcast with at least 14 day spray interval. Do not treat seeded tomatoes until 5 to 6 leaf stage or transplants until they have recovered from shock. Do not apply within 3 days of cool, wet, or cloudy weather, or crop injury may occur. No more than 1.33 lb. 75DF per crop season. 7 day PHI.
Select 2E	6 to 16 fl. oz. per acre plus 1 qt. COC per 25 gal. spray solution.	Apply to actively growing grass. Do not apply more than 1 qt. per acre per year. 20 day PHI.
paraquat (2.5 lb./gal.)	1.5 pt. per acre plus 1 qt. COC or nonionic surfactant per 25 gal. spray solution.	DIRECTED SPRAY ONLY. Apply to emerged weeds between crop rows. Do not allow spray to drift onto crop. 30 day PHI.
NON-SELECTIVE HERBICIDES		
paraquat (2.5 lb./gal.)	2 to 3 pt. plus 1 qt. COC or 4 to 8 fl. oz. nonionic surfactant per 25 gal. spray solution.	When direct seeding, apply just before tomatoes emerge if resistant broadleaves emerge. RUP.
glyphosate	0.75 to 1.1 lb. acid equivalent (ae) per acre, equivalent to: 32 to 48 fl. oz. of 3 lb. ae/gal.; 26 to 40 fl. oz. of 3.7 lb. ae/gal.; 24 to 36 fl. oz. of 4 lb. ae/gal.; 1.2 to 1.8 lb. of 64.9% ae WSG.	Some formulations permit spot spray application - check label. Apply to emerged weeds before planting crop. These rates are for annual weeds at application volumes of 10-40 gal. per acre. See label for rates at lower application volumes, for perennial weeds, and suggested adjuvants.

* For specific weeds controlled by each herbicide, check table on page 30.

** Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Flea beetles	Monitoring.	Flea beetles often infest tomato seedlings and transplants. Plants should be examined frequently to determine the need for insecticide applications.
Threshold 30% defoliation	Warrior 1EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. **Not for cherry tomatoes.** 5 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	1 day PHI.
	OR	
	Sevin 50WP at 2 lb., 80SP at 1.25 lb., or XLR Plus at 1 qt. per acre.	3 day PHI.
	OR	
	Guthion 2S at 2 to 3 pt. or 50WP at 1 to 1.5 lb. per acre.	Do not exceed 4 applications per season. Allow 7 days between applications. 0 day PHI at low rates. 14 day PHI at rates above 3 pt. or 1.5 lb.
	OR	
	Methoxychlor 2 EC at 1 to 3 pts. per acre.	7 day PHI, 1 day PHI if 1 pt. rate is used.
	OR	
	Actara 25WDG at 2 to 3 oz. per acre.	Do not exceed 8 oz. per acre per season.
Colorado potato beetle and larvae	Populations of Colorado potato beetles are exhibiting resistance to many insecticides in some areas of the Midwest. If a previously effective insecticide is no longer effective, consider switching to another chemical class (pyrethroids, carbamates, organophosphates, cyclodienes, or *Bacillus thuringiensis*).	
	Crop Rotation.	Planting fields as far as possible away from last year's tomatoes or potatoes will reduce potato beetle damage.
Threshold 1 beetle, larva, or egg mass per plant.	Cultural Control.	The use of straw mulch reduces potato beetle damage.
	Scouting.	Regular (weekly) scouting of fields will allow you to determine the necessity for, and improve the timing of, insecticide treatments.
	Admire 2F at 16 to 24 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. Admire or Provado per acre per season. 21 day PHI.
	OR	
	Provado 1.6F at 3.75 fl. oz. per acre.	Do not exceed 18.75 fl. oz. per acre per season. Allow 5 days between applications. 0 day PHI.
	OR	

INSECTS CONTROLLED	TREATMENT	COMMENTS
Colorado potato beetle and larvae (cont.)	Actara 25WDG at 2 to 3 oz. per acre.	Do not exceed 8 oz. per acre per season.
	OR	
	SpinTor 2 SC at 2.25 to 4.5 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1 day PHI.
	OR	
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0 day PHI.
	OR	
	Warrior 1EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. **Not for cherry tomatoes.** 5 day PHI.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.35 lb. a.i. per acre per season. 1 day PHI.
	OR	
	Guthion 50 WP at 0.75 lb. or 2S at 1.5 pt. per acre.	0 day PHI.
	OR	
	Thiodan 50WP at 1 to 2 lb. or 3EC at 0.67 to 1.33 qt. per acre.	Do not exceed 6 applications, or 3 lb. a.i. per acre per season. 2 day PHI.
	OR	
	M-Trak at 1.5 to 4.0 qt. per acre, or Novodor at 1.0 to 4.0 qt. per acre.	*Bacillus thuringiensis* based insecticides. Control only small larvae. Other materials will need to be used to control adults and large larvae. 0 day PHI.
	OR	
	Agri-mek 0.15EC at 8 to 16 fl. oz. per acre.	Allow at least 7 days between applications. Do not exceed 48 fl. oz. per acre per season. No more than two successive applications. 7 day PHI.
	OR	
	Ambush 2EC at 3.2 to 12.8 fl. oz. or 25WP at 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** 1 day PHI.
	OR	
	Pounce 3.2EC at 2 to 8 fl. oz. or 25WP at 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** 1 day PHI.
Cutworms	Warrior 1EC at 1.9 to 3.2 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. **Not for cherry tomatoes.** 5 day PHI.
Threshold	OR	
1 cutworm per 100 plants	Baythroid 2E at 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0 day PHI.
	OR	

INSECTS CONTROLLED	TREATMENT	COMMENTS
Cutworms (cont.)	Sevin 50WP at 4 lb., 80SP at 2.5 lb., or XLR Plus at 2 qt. per acre.	3 day PHI.
	OR	
	Pounce 3.2EC at 2 to 8 fl. oz. or 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** Do not exceed 1.2 lb. a.i. per acre per season.
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	Do not exceed 0.35 lb. a.i. per acre per season. 1 day PHI.
	OR	
	Lannate LV at 1.5 pt. or 90SP at 0.5 lb. per acre.	1 day PHI.
Hornworms	Warrior 1EC at 1.9-3.2 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. **Not for cherry tomatoes.** 5 day PHI.
	OR	
Threshold 0.5 larvae per plant	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0 day PHI.
	OR	
	Guthion 50WP at 1.5 to 3 lb. or 2S at 3 to 6 pt. per acre.	1.5 lb. rate, 0 day PHI; higher rates, 14 day PHI.
	OR	
	Sevin XLR Plus at 2 qt. per acre.	3 day PHI.
	OR	
	Asana XL at 2.9 to 5.8 fl. oz. per acre.	1 day PHI.
	OR	
	Bacillus thuringiensis (MVP, Javelin, Dipel, Lepinox, Cutlass, Biobit, Agree, Xentari, Ketch). Follow label directions.	0 day PHI.
	OR	
	SpinTor 2 SC at 3 to 6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1 day PHI.
	OR	
	Ambush 2EC at 3.2 to 12.8 fl. oz. or 25WP at 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** 1 day PHI.
	OR	
	Pounce 3.2EC at 2 to 8 fl. oz. or 25W at 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** 1 day PHI.
	OR	
	Danitol 2.4EC at 10 2/3 fl. oz. per acre.	Do not exceed 42 2/3 fl. oz. per acre per season. 3 day PHI.
	OR	
	Avaunt WDG at 2.5 to 3.5 oz. per acre.	Do not exceed 14 oz. per acre per season. 3 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Stink bugs	Thiodan, Endosulfan, or Phaser 50WP at 1 to 2 lb. or 3EC at 0.67 to 1.33 qt. per acre.	Do not exceed 6 applications or 3 lb. a.i. per acre per season. 2 day PHI.
	OR	
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0 day PHI.
	OR	
	Warrior 1EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. 5 day PHI. **Not for cherry tomatoes.**
	OR	
	Actara 25WDG at 3 to 4 oz. per acre.	Do not exceed 8 oz. per acre per season. 0 day PHI.
Fruitworms (= corn earworm)	Pheromone Traps.	Pheromone traps effectively detect fruitworm moth activity and help improve the timing of insecticide applications.
Threshold 7 moths per pheromone trap per week and fruit present	Warrior 1EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. **Not for cherry tomatoes.** 5 day PHI.
	OR	
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0 day PHI.
	OR	
	Sevin 50WP at 4 lb., 80SP at 2.5 lb., or XLR Plus at 2 qt. per acre.	3 day PHI.
	OR	
	Lannate 90SP at 0.5 to 1 lb. per acre, or LV at 1.5 to 3 pt. per acre.	1 day PHI. Will also control aphids.
	OR	
	Asana XL at 5.8 to 9.6 fl. oz. per acre.	1 day PHI.
	OR	
	Danitol 2.4EC at 10 2/3 fl. oz. per acre.	Do not exceed 42 2/3 fl. oz. per acre per season. 3 day PHI.
	OR	
	Bacillus thuringiensis (MVP, Javelin, Dipel, Lepinox, Cutlass, Biobit, Agree, Kentari, Ketch). Follow label directions.	0 day PHI.
	OR	
	SpinTor 2 SC at 3 to 6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1 day PHI.
	OR	

INSECTS CONTROLLED	TREATMENT	COMMENTS
Fruitworms (= corn earworm) (cont.)	Ambush 2EC at 3.2 to 12.8 fl. oz. or 25WP at 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** 1 day PHI.
	OR	
	Pounce 3.2EC at 2 to 8 fl. oz. or 25W at 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** 1 day PHI.
	OR	
	Avaunt 30WDG at 3.5 oz. per acre.	Do not exceed 14 oz. per acre per season. 3 day PHI.
Aphids	Conserve natural enemies.	Limiting the use of insecticides will conserve predators and parasites that help keep aphid populations under control.
	Admire 2F at 16 to 24 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. Admire or Provado per acre per season. 21 day PHI.
	OR	
	Provado 1.6F at 3.75 fl. oz. per acre.	Do not exceed 18.75 fl. oz. per acre per season. Allow at least 5 days between applications. 0 day PHI.
	OR	
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0 day PHI.
	OR	
	Fulfill 50WG at 2.75 oz. per acre.	Do not exceed 5.5 oz. per acre per season. 14 day PHI.
	OR	
	Thiodan, Endosulfan, or Phaser 50WP at 1 to 2 lb. or 3EC at 0.67 to 1.33 qt. per acre.	Do not exceed 6 applications, or 3 lb. a.i. per acre per season. 2 day PHI.
	OR	
	Lannate LV at 1.5 to 3 pt. or 90SP at 0.5 to 1 lb. per acre.	1 day PHI.
	OR	
	Dimethoate at 0.75 to 1.5 pt. per acre.	4 day REI. 7 day PHI.
	OR	
	M-Pede at 1 to 2% by volume.	Must contact aphids to be effective. 0 day PHI.
	OR	
	Actara 25 WDG at 2 to 3 oz. per acre.	Do not exceed 8 oz. per acre per season. 0 day PHI.
Russet mite	AgriMek 0.15EC at 8 to 16 fl. oz. per acre.	Do not exceed 48 fl. oz. per acre per season. 7 day PHI.
	OR	
	Wettable sulfur (84 to 95%) at 10 lb. per acre.	Sulfur dusts are also effective. Thorough coverage is required. Do not apply when temperatures are above 95°F or during a heavy dew.

INSECTS CONTROLLED	TREATMENT	COMMENTS
Fruit flies, vinegar flies (*Drosophila* spp.)	Use all of these procedures to prevent contamination of tomato products by fruit fly eggs and maggots: (1) Provide *unplanted* driveways through field to prevent fruit damage. (2) Starting 2 weeks before harvest, place bait fruits in fields in late afternoon, and examine next morning. (3) If half of the baits show eggs, spray fields immediately and at 4-6 day intervals with:	Harvesting Tips: (1) Avoid crushing fruit with trucks or spray equipment. (2) Pick fruit carefully to avoid bruising. (3) Fill hampers, boxes, and trucks in such a way that fruits will not be damaged during transit. (4) Do not allow filled hampers to remain in the field overnight. (5) Process tomatoes the same day they are picked and as rapidly as possible. (6) Keep hampers and trucks clean.
	Diazinon 50WP at 1.5 lb. or AG500 at 1.5 pt. per acre. (4) Dust fruit and hampers as soon as filled with a dust containing 0.1% stabilized pyrethrins plus 1.0% piperonyl butoxide. (5) Move hampers to processing plant as soon as possible.	1 day PHI.
Whiteflies	Align or Neemix according to label directions. OR Admire 2F at 16 to 24 fl. oz. per acre. OR Provado 1.6F at 3.75 fl. oz. per acre. OR M-Pede at 1 to 2% by volume. OR Vydate L at 2 to 4 pt. per acre. OR Thiodan, Endosulfan, or Phaser 3EC at 0.67 qt. per acre.	0 day PHI. Do not exceed 0.5 lb. a.i. Admire or Provado per acre per season. 21 day PHI. Do not exceed 18.75 fl. oz. per acre per season. Allow at least 5 days between applications. 0 day PHI. Must contact whiteflies to be effective. 0 day PHI. 1 day PHI. 2 day PHI.

INSECTS CONTROLLED	TREATMENT	COMMENTS
European corn borer		Usually 3rd generation, most commonly in hot year.
	Warrior 1EC at 2.6 to 3.8 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. **Not for cherry tomatoes.** 5 day PHI.
	OR	
	Baythroid 2E at 1.6 to 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0 day PHI.
	OR	
	SpinTor 2 SC at 4 to 8 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1 day PHI.
	OR	
	Ambush 2EC at 3.2 to 12.8 fl. oz. or 25WP at 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** 1 day PHI.
	OR	
	Pounce 3.2EC at 2 to 8 fl. oz. or 25W at 3.2 to 12.8 oz. per acre.	**Not for cherry tomatoes.** 1 day PHI.

Calibration of Application Equipment

Rate of application, granular and sprays, may vary with materials used. Equipment must be calibrated for each material applied to obtain accurate delivery. Here are suggested steps to calibrating three types of applicators.

BOOM SPRAYER

1. Clean sprayer, and replace all worn or defective parts; fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 1/4 acre (10,890 sq. ft.). Distance of travel will vary with boom width. For example, a 22 ft. boom must travel 495 ft. to cover 1/4 acre:

$$\frac{\text{1/4 acre (10,890 sq. ft.)}}{\text{Boom width (22 ft.)}} = \text{distance of travel (495 ft.)}$$

4. Measure amount of water needed to refill the tank. This amount was applied to the 1/4 acre; thus, four times this amount is the gallonage per acre.
5. Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
6. Calculate acres covered by tank of spray solution, and add required amount of pesticide for total area sprayed.

BAND SPRAYER

1. Clean sprayer, and replace all worn or defective parts; fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 1/4 acre (10,890 sq. ft.). Distance traveled will vary with number of rows on the planter and row width. For example, band spraying over 4 rows spaced 40 inches requires 817 ft. to cover 1/4 acre:

$$\frac{\text{1/4 acre (10,890 sq. ft.)}}{\text{Rows (4) x row widths (3.33 ft.)}} = \frac{\text{10,890 sq. ft.}}{\text{13.33 ft.}} = \text{distance of travel (817 ft.)}$$

4. Measure amount of water needed to refill the tank. This amount was applied to the 1/4 acre; thus, four times this amount is the gallonage per acre.
5. Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
6. Calculate acres covered by tank of spray solution, and add required amount of pesticide for total actual area to be band treated.

GRANULAR BAND APPLICATOR

1. Set applicator dial or dials to give desired delivery rate of granules suggested for band treatment according to manufacturer's instructions.
2. Fill hoppers with granules to be used.
3. Travel across field at planting speed for the distance required to cover 1/16 acre (2,722 sq. ft.) per row. Collect granules for each row in a bag, bucket, or other container. For example: granular band application for a 40-inch row requires 817 ft. to cover 1/16 acre:

$$\frac{\text{1/16 acre (2,722 sq. ft.)}}{\text{Row width (3.33 ft.)}} = \text{distance to travel (817 ft.)}$$

4. Weigh granules from each row separately, and multiply by 16 to find delivery per acre for each row.
5. Adjust each setting, and recalibrate until the desired delivery rate is obtained.

Pesticide Application Record* and Written Notification for EPA Worker Protection Standards#

BUSINESS NAME

LOCATION		PESTICIDE				APPLICATION								
Field	Crop	Product Brand Name & Chemical Formulation+	Active Ingredient	Name of Manufacturer	EPA Registration Number	Pest Controlled	Area Treated (Sq. ft. or Acres)	Pesticide Rate	Total Amount of Pesticides Used	Name & Certification No. of Applicator or Certified Supervisor	Date (Mo./Day/Yr.)	Time	Restricted Entry Interval (Hrs)	OK to Enter (Date & Time)

*Information required by Federal and State Recordkeeping Requirements for Certified Applicators of Federally Restricted Use Pesticides (RUP). Records for restricted use pesticides must be maintained for 2 years from dat eof pesticide application.
#For EPA Worker Protection Standard, information in shaded columns must be recorded for all pesticides and be maintained at the centrally located posting area for 30 days after restricted entry interval expires.
+Formulation required if included in product name: G=granules, F=flowable, L-liquid, WP&W=wettable powder, EC&E=emulsifiable concentrate, S-soluble, ULV=ultra low volume, DF=dry flowable, etc.

This form was prepared as a joint effort of the Northwest Commercial Horticulture Program, Dept. of Horticulture, and Purdue Pesticide Programs, Purdue University, West Lafayette, IN 47907

This Cooperative Extension Service of Purdue University is an affirmative action/equal opportunity institution.

Notes

Notes

706 03\04 78
34747

Illinois Horticulture/Food Crops & Integrated Pest Management Educators

Food Crop Horticulture

Office Location	Educator	Address	Office Phone
St. Charles Horticulture Research Center	William Shoemaker	535 Randall Rd. St. Charles, IL 60174	(630)584-7254
Edwardsville Extension Center		University of Illinois 200 University Park Dr. University Park SIU-E Edwardsville IL 62025-3636	(618) 692-9434
Dixon Springs Agricultural Center		Rt. 1, Box 256 Simpson, IL 62985	(618)695-2444

Integrated Pest Management

Office Location	Educator	Address	Office Phone
Champaign Extension Center	Suzanne Bissonnette	1401D Regency East Savoy IL 61874	(217) 333-4901
Countryside Center	Maurice Ogutu Joerg Schmidt-Bailey	6438 Joliet Road Countryside IL 60525	(708) 352-0109
Matteson Extension Center	Russell Higgins	5527 Miller Circle Dr. Matteson, IL 60443	(708)720-7520
Mt. Vernon Extension Center	Mark Hoard	4112 N. Water Tower Pl. Mt. Vernon, IL 62864	(618)242-9310
Quad Cities Extension Center	Dave Feltes	1414 10th St., Suite 2 Silvis IL 61282	(309) 792-2500
Springfield Extension Center	George Czapar Pablo Kalnay	P.O. Box 8199 Springfield IL 62791	(217) 782-6515

UNIVERSITY OF ILLINOIS-URBANA
3 0112 061060577

Production Facts

Serving Size - 1 Book

Varieties	100%
Fertility	100%
Irrigation	100%
Transplant Production	100%
Pest Management Strategies	100%
Pre-harvest Intervals	100%
Re-entry Intervals	100%
Nematode Control	100%
Insect Control	100%
Disease Control	100%
Weed Control	100%

UNIVERSITY OF ILLINOIS
EXTENSION

The University of Illinois Extension provides equal opportunities in programs and employment.

Extension Vegetable Crop Production Web Sites

Illinois Fruit & Vegetable News
http://www.aces.uiuc.edu/~ipm/news/fvnews.html

Iowa State University
http://www.hort.iastate.edu

Minnesota VegEdge
http://vegedge.umn.edu

Ohio Veg Net
http://www.ag.ohio-state.edu/~vegnet/

Purdue Vegetable Crops Hotline
http://www.entm.purdue.edu/entomology/ext/targets/newslett.htm

Radcliffe's IPM World Textbook
http://www.ipmworld.umn.edu

UNIVERSITY OF ILLINOIS-URBANA
3 0112 048259383